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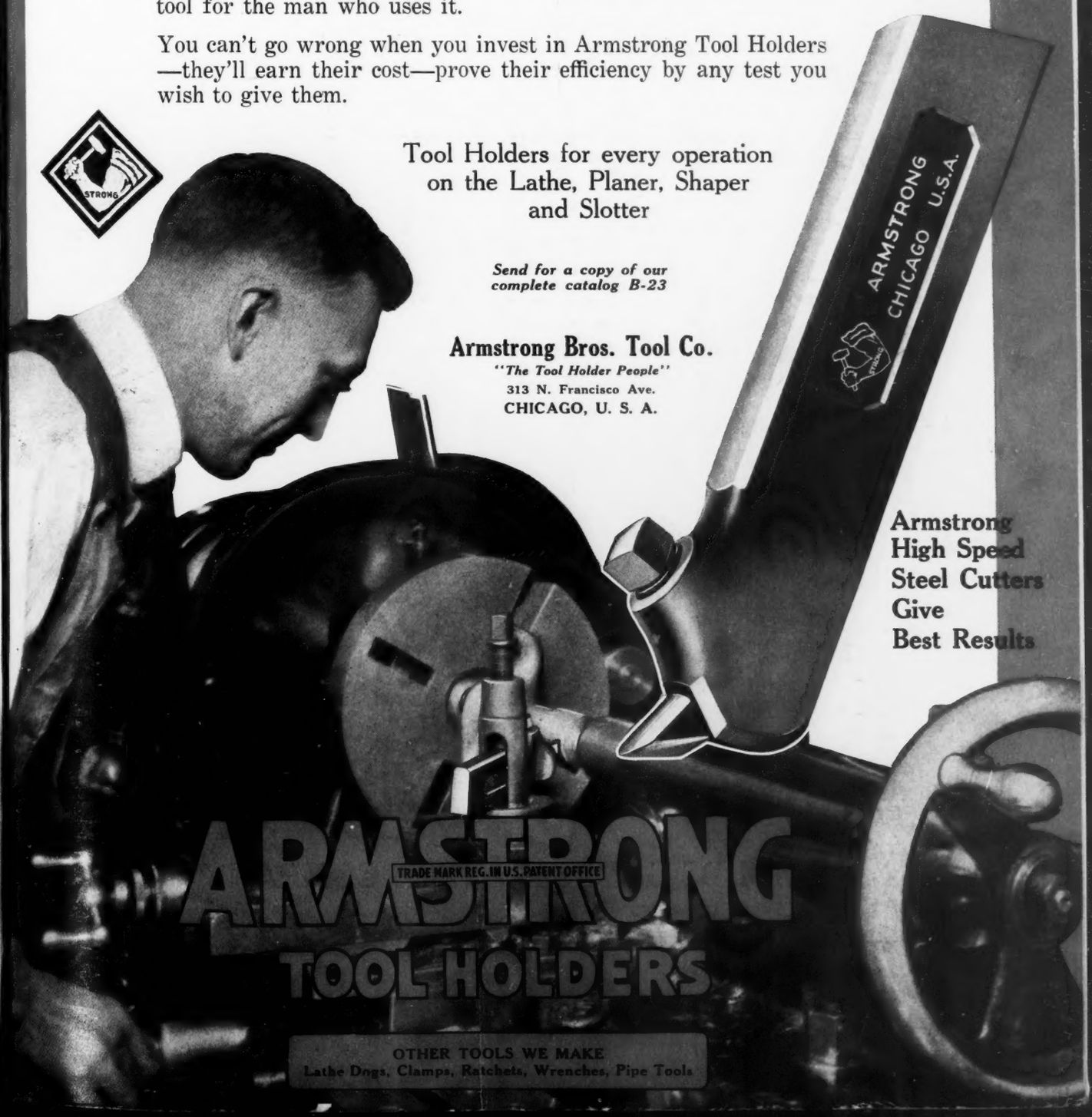

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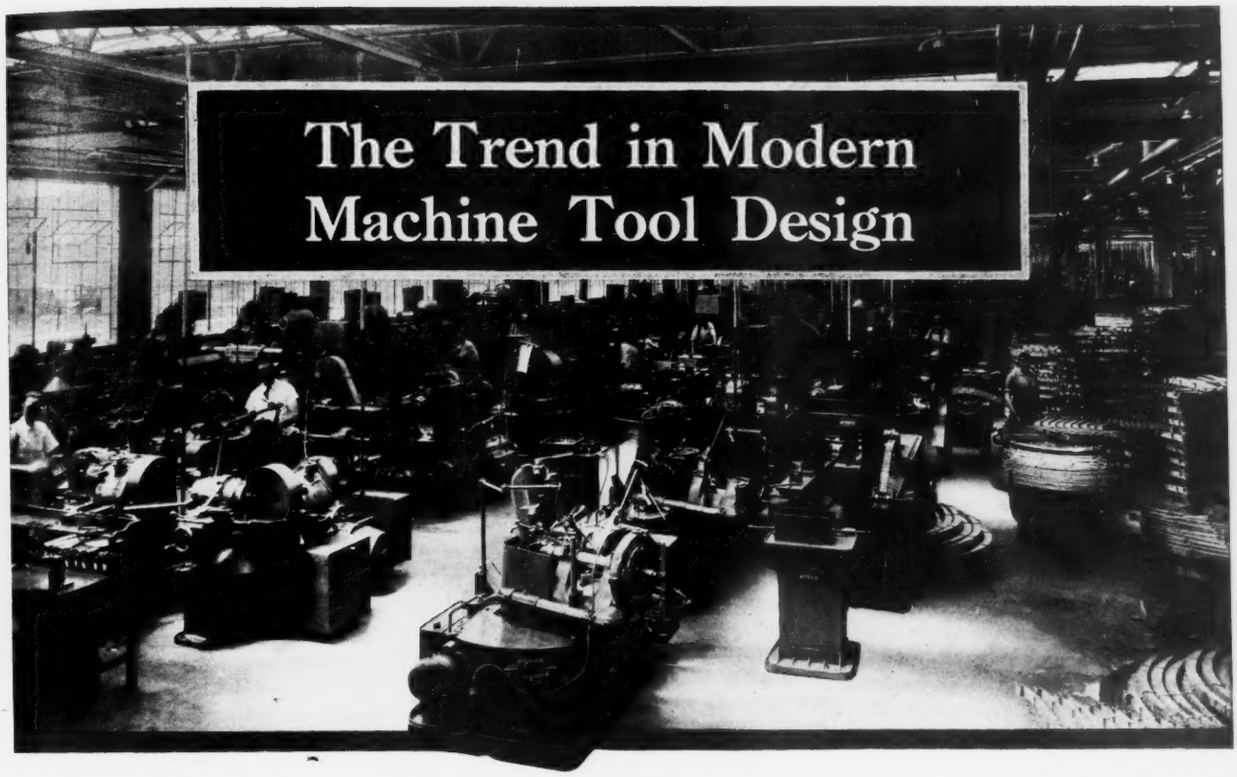


The Trend in Modern Machine Tool Design

Condensed Review of Recent Changes and Developments of Importance to Users of Machine Tools

THE progressiveness of the machine tool and allied industries in developing equipment to meet the large variety of conditions encountered in manufacturing practice is indicated by the numerous designs of new and improved machine tools and auxiliary devices that are continually being introduced. In order to focus attention more completely on current and recent developments, a summary covering important features of modern equipment will be given. It is evident that a complete record, even of recent designing progress, would be impracticable within the limits of this article, as such a record would necessarily include, in addition to the more general features of design, a great many improved details which, although important, cannot readily be dealt with in a general summary. However, an attempt will be made to cover certain important changes and improvements, and include concrete examples from practice selected primarily to illustrate the general trend of present-day developments. It is believed that a review of this kind will be of interest and value to users of machine tools in various lines of manufacture.

A study of modern machine tools will show that different designs are based upon factors that often vary widely. For example, the primary requirement for a machine tool may be either rapid production, accurate production, simplicity of design, or adaptation to a wide range of work. It is largely because of these varying and related factors that machine tools, even of the same general type, are often made in a number of different designs. Then, too, the efficiency of a given machine and its durability under service conditions are points that have a most decided influence upon the design and general arrangement. Many notable improvements have been made in adapting modern equipment to service conditions, and also in securing higher efficiency combined with a more reliable and durable design.

Preservation of the original accuracy or alignment between important machine tool members, by minimizing wear and providing adequate means of compensating for unavoidable wear, involves not only the design of adequate bearing surfaces or the use of special bearings, but effective lubrication, as well as protection against dust or gritty material that might injure the bearing surfaces. The elimination of excessive vibrations is another fundamental requirement which has been considered very carefully by machine tool builders. Vibrations that might be tolerated in machines of other classes are objectionable in machine tools, as they dull the edges of cutters and mar the work, thus affecting both the quantity and quality of the product. The direct relation between these different factors and the designs of various types of machine tools, is indicated by many of the features mentioned in this brief review.

In many lines of manufacture outside of the machine-building field, the equipment used is subject to comparatively little change in design, as manufacturing requirements and conditions remain practically the same. But in the machine-building industry, an almost endless variety of conditions is encountered, due to the limitless range of sizes, shapes, materials, and degrees of accuracy involved in the construction of mechanical appliances of different types. The accomplishments of the machine tool industry in developing equipment to meet these diversified conditions represent many notable achievements in engineering and manufacturing practice.

Increasing Output through Convenience of Control

If machines are largely under manual control, and especially if the work is such that frequent starting, stopping, and feed changing are necessary for the usual run of work, it is evident that a centralized control with all levers so arranged as to prevent waste of time or energy is particularly important. The builders of modern machine tools have studied this point very carefully, as will

be apparent to all who read the descriptions of the new or improved designs brought out from time to time. Just by way of illustration, there are two adjoining levers on a certain type of machine; one has a ball-shaped end and the other a handle of the usual form. The object of using different shapes is to enable the operator to identify instantly and without effort each of these two levers.

Much attention has been paid to the location of levers relative to the operator's normal working position, and in addition, considerable progress has been made in reducing the number of controls, as well as in simplifying their arrangement. The matter of safeguarding both the operator and the machine itself represents additional points commonly incorporated in modern design. Several examples from practice will be cited, merely to illustrate some present-day methods of control.

According to one arrangement for a universal grinding machine, the table and work are controlled by a hand-lever within convenient reach of the operator, and the hand cross-feed and quick traverse are controlled by a single handwheel which has two positions, one engaging the cross-feed and the other disengaging this feed and engaging the quick traverse. The elevating and lowering mechanism for the arm of a radial drilling machine is so arranged that a single movement of one lever controls the unclamping, elevating, and lowering, reclamping being effected by the same lever. Incidentally, there are automatic trips at both extremes of the arm's travel, and the gearing is automatically disengaged if any obstruction is encountered while elevating or lowering the arm; thus the machine is protected without depending on the operator.

The feed and power rapid traverse for a vertical boring mill are interlocked by a cam arrangement which disengages one before the other can be engaged, and the power rapid traverse and feeds may be engaged, disengaged, or reversed directly from the saddles by levers on the operator's side. A milling machine of the column-and-knee type has eighteen progressive spindle speeds, which are controlled by only two levers, these being mounted on the side of the column adjacent to the index-plate.

The lever for controlling the rapid traverse on a gear-hobbing machine is so interlocked with the feed-lever that the feeding movement and power traverse cannot be engaged simultaneously. There is an additional safety feature to prevent accidental operation of the rapid traverse in a downward direction, this movement being automatically disconnected at any predetermined point, thus preventing injury to the hob and the blanks and at the same time making it convenient to set the hob readily in the cutting position.

A rotary type of surface grinder is so arranged that the downward movement of the wheel-slide closes an electrical circuit through the rotary magnetic chuck, thus operating a clutch which starts the chuck rotating and brings the wheel in contact with the work. Raising the wheel-slide after the grinding operation is completed, automatically stops the chuck rotation, breaks the electrical circuit through the chuck and for an instant closes the circuit in an opposite direction, thus demagnetizing the chuck face and facilitating the removal of work.

On a certain geared-head lathe a spindle control lever is located at the right-hand end of the apron and also on the headstock for starting and stopping. One of the heavy-duty geared-head lathes has a rapid traverse mechanism which makes it unnecessary to move the carriage by hand. One lever controls both feed and traverse, a horizontal movement engaging or disengaging the feed, and a vertical movement engaging the traverse. Incidentally, the rate of traverse is 150 inches per minute.

Still another example of improvements made in the control and adjustment of modern machine tools is represented by planers which have all of the controls grouped on the operator's side. In one instance, shifting a lever serves to move a head into any desired position; another lever raises or lowers the slide; and a third control provides vertical adjustment of the cross-rail. This rail may also be clamped after adjustment by a few turns of a screw at the right hand end of the rail, which serves to lock both ends to the inner edge of each housing.

It will be understood that the foregoing examples are not intended as a complete list of recent improvements in control, but rather as a few specific examples which show the general tendency in regard to this important matter. Furthermore, some of the arrangements referred to are duplicated in principle, at least, on various other machines not specifically mentioned.

The most important requirement of a machine tool may be (1) rapid production, (2) accurate production, (3) adaptation to a wide range of work, or (4) simplicity of design. It is largely because of these varying factors, which are related in different ways, that a given type of machine tool is often made in a number of different designs to meet commercial conditions. Success in the construction of modern tool equipment depends, in fact, upon a thorough knowledge of service requirements, and present-day developments indicate that this fact is being recognized by machine tool builders.

Developments in Machine Tool Transmissions

The methods of transmitting power in machine tools, both for driving cutters or work as well as for transmitting feeding movements, have been subject to constant improvements. Helical gears for connecting parallel shafts are being used more and more to secure a smooth transmission free from injurious vibrations, and the use of special steels and heat-treated gearing is quite general, the hardened gears in some cases being ground to eliminate even the slight distortions caused by heat-treatment.

An engine lathe (recently introduced) is equipped exclusively with heat-treated chrome-nickel steel helical gears in the headstock, and ball bearings are employed in conjunction with these gears. Helical gears have been applied to a five-spindle automatic in order to secure smoother action and a higher degree of uniformity in transmission. The spindles of another multiple-spindle automatic of recent design are driven from a central shaft through hardened helical gears. The table drive of a planer is provided with gearing of the balanced helical type, there being right- and left-hand helical gears so arranged as to balance torsional effect. A bull gear and pinion having helical teeth have been applied to a heavy-duty shaper. A double helical feed rack drive has been applied to the spindle of a high duty drilling machine. In view of the fact that this machine has driven a 1¼-inch drill through cast iron at the rate of 116 feet per minute, the importance of a substantial feed mechanism is apparent.

Methods of controlling speeds and feeds are being simplified more and more, so that operators can readily determine how to make changes, thus being encouraged to alter speeds or feeds whenever this would be advantageous from the viewpoint of production. Some lathes having a fairly long bed and variable-speed motor drive, are equipped with electrical apron control, so that starting, stopping, or reversal may be regulated from the carriage. One of the internal grinding machines has six different speeds for the work-head spindle, any one of which may be obtained by turning a handwheel to the position indicated for that speed.

A special boring machine is so arranged that all table speeds are now obtained electrically from a variable-speed motor, instead of employing sliding gear transmission, as formerly. On a radial drilling machine, shocks when changing speeds are overcome by means of a self-releasing overtake clutch, which causes the machine to run at its slowest speed when making changes. The speed-box in this case is a cone and tumbler type controlled by a single lever.

One of the recent lathes, which has eighteen spindle speeds, is so arranged that twelve of these speeds are obtained through an internal gear on the faceplate, the plan being

to drive through the internal gear for all of the heavier turning operations. A speed-reducing faceplate, which is in the form of an attachment, has been developed primarily for use in relieving operations that require relatively slow spindle rotation. This faceplate attachment, which is designed for a 16-inch lathe, provides a 6 to 1 reduction for whatever spindle speed is engaged, and speeds as low as 2 revolutions per minute may be obtained. A gear attached to the lathe spindle transmits motion through two planetary gears and a large fixed internal gear to the driving member or faceplate proper.

If a machine must be started or stopped frequently, some form of brake is often a decided advantage. As an example, an axle lathe, when driven by either a single pulley or an alternating-current motor, has an automatic brake, the drive being through a friction clutch and this brake. If a direct-current motor is used, a dynamic brake in the controller is employed for rapid stopping, operation being by a conveniently located push-button. One of the geared-head lathes is provided with a friction clutch and brake, which is operated either by a lever at the apron or one at the headstock: this enables the operator to start and stop the machine and to apply the brake without leaving his working position.

Feeding Mechanisms of the Cam Type

Feeding mechanisms naturally are subject to considerable variation in design, since some machine tools need a wide range of feeds with frequent changes, and others a small range with few or no changes over long periods. Gear combinations of various kinds are used on a large percentage of the machine tools, although special arrangements are sometimes used to advantage. For instance, a drilling and boring machine introduced quite recently has a cam type of feed. This machine is intended particularly for facing operations, and the cam is designed to feed the cutter to the required depth and then dwell at that point somewhat before withdrawing the spindle. In the same way, cams may be provided for intermittent drilling and boring, the design being such as to advance the spindle rapidly to the working position. This machine is, of course, intended for quantity production. Special drilling machines of the multiple-spindle type are often equipped with cam-operated feeding mechanisms. A special three-way drilling machine for valve body flanges or similar work is one example. This machine is provided with drum cams which give a quick forward travel, a slow feed, and a quick return. Various feeds are obtained through change-gears.

One of the more recent shapers is equipped with a cam for actuating the feeding motion instead of the usual crank. This cam is intended to provide a gradual rather than an abrupt feed, but with the feeding movement confined within the return stroke.

Motor Drives as Applied to Machines of Recent Design

The general introduction of motor drives as integral parts of machine tools has resulted in improved methods of mounting so as to minimize vibrations and have the motor blend in with the general design to better advantage. It is not uncommon to find motors installed inside the base or frame in the case of machine tools having suitable interior spaces. One of the motor-driven surface grinders has the motor inside the base so that it is protected from dust and grinding compounds, and the floor space required for the grinder is reduced correspondingly. A portable threading, cutting, and reaming machine has the motor mounted on a hinged table within the base. A demountable hand-crank is used for raising the motor to release the driving belt and stop the machine.

In some machine-building plants, the equipment must be capable of general application; in others, where quantity production is necessary, highly specialized machines, including automatic and single-purpose designs, are needed. Between these two extremes there are machine tools intended primarily for quantity production, which have some of the flexibility of the general-purpose machines, but a simplified design as compared with the more special tools. This variety in the designs produced shows to what extent machine tool builders base their developments on commercial conditions.

Motors arranged for speed variations have been utilized to advantage on some machine tools for securing speed changes without employing variable-speed transmissions of the geared type. As an example, a recent design of cylindrical grinding machine (intended primarily for grinding locomotive piston-rods) has a motor on the headstock, which drives the work and provides the necessary speed changes.

Motor location as well as the method of transmitting power to the driven parts of the machine are, of course, governed largely by the type of machine and its general design. An interesting application of motors to a motor-driven cutter and tool grinder is so arranged that the overhead countershaft and superstructure previously used is eliminated, as the motors are mounted on the machine and are directly connected to it. A ½-horsepower motor on top of the column drives the grinding wheel spindle and a ⅛-horsepower motor serves to rotate the headstock and work in performing cylindrical or internal grinding operations. A third motor of ¼ horsepower provides the longitudinal power feed through a suitable gear-box. It is claimed that this type of drive has resulted in a power saving of 50 per cent, as compared with the overhead structure.

In the case of motor-driven lathes, the motor may either be on the headstock or occupy a low position on the rear of the bed. Transmission from the motor may be through a silent chain, leather belt, or through spur or helical gearing, depending upon the arrangement of the headstock and the preference of the manufacturer. Examples of these different arrangements will be found in connection with lathes recently introduced. A heavy 36-inch lathe of modern design has the motor mounted on the headstock, and transmission to the initial driving shaft is through herringbone gears. This is one more example illustrating the increasing use of gearing of the helical type.

On a heavy-duty milling machine of the horizontal type, the feed motor has a special control by means of which the pulling power is eased slightly, provided the cutter meets unusual resistance due either to excess metal or hard spots. This is considered a valuable aid in preserving the cutters. A tool grinder brought out during the past year has a motor of the fully enclosed dustproof type, although the power capacity is said to be almost as great as for a motor of the open type of corresponding dimensions. On the spindle of the enclosed motor just inside the bearings there are two fans which force currents of air through the electric windings and then against the grinding wheel guards. In this way the heat of the motor is transferred from the windings to the guards, which are made of aluminum and are therefore good conductors of heat.

Increasing Use of Hydraulic Transmissions

The hydraulic form of transmission has replaced the mechanical transmission on certain machine tools, and the present trend is toward a wider application of the hydraulic type. This form of transmission is utilized with the idea of obtaining an unusually smooth action, and flexibility of control that is beyond the range of a mechanical transmission. In machine tool design, the hydraulic transmission has been utilized more particularly for grinding machines. For example, on a cylindrical grinder of the high production type, the work carriage is traversed hydraulically at any speed from 6 inches to 40 feet per minute. A regulating valve, located at the front near the operating position, provides the control for the drive. Oil pressure is supplied by a geared pump, and the entire base of the machine serves as an oil container. Motion is transmitted to the traversing

carriage through the lever arrangement, which is so arranged as to permit a comparatively low pressure in the oil cylinder, thus eliminating excessive packing around the valves and joints.

An interesting application of the hydraulic principle is found on a double-spindle disk grinder, which has a hydraulic feed for operating the sliding heads through a double-acting hydraulic cylinder. Oil, under the required pressure, is supplied to the operating cylinder by a pump, driven either from a countershaft or by an individual motor. The mechanism is protected against excessive pressure by two relief valves in the pump, one being for the feed and one for the return motion. These valves are set to give the maximum grinding pressure suitable for ordinary wheels.

Other examples of machine tools which have been equipped with hydraulic transmissions include an automatic ring grinder, an internal grinder, and a broaching press. The ring grinding machine has a hydraulically operated wheel-slide. Any speed from zero to maximum may be obtained instantly, and it is possible to reverse the table at any point without shock. An internal grinding machine is so arranged that the speed of the table traverse is controlled through a very sensitive throttle valve which admits oil under pressure to a distributing valve. The latter is controlled by the table limit stops, and from it oil is conveyed to either end of a double-acting cylinder and piston mechanism connecting with a cross-head on the under side of the table. This arrangement provides a very flexible table control.

A vertical design of broaching and assembling press, which is operated hydraulically, may be arranged to have the ram speed changed either automatically or manually at any point of the stroke. These speed changes, as well as the reverse movement, are said to occur instantly and without shock or jar, and the ram is given a steady movement which is particularly suitable for broaching.

As previously pointed out, the question of vibration is one that has received the attention of machine tool builders generally. Injurious vibrations are avoided in some cases by the use of massive members that are very much stronger and heavier than required for strength alone. Particular attention is also being given to torsional vibrations, such as occur, for example, when power is transmitted through comparatively long shafts.

A lathe of quite recent design has the entire driving mechanism directly under the spindle and below the ways of the bed, the object being to balance the lathe and minimize vibrations. On a certain drilling, boring, and tapping milling machine, the motor for driving the spindle, as well as the intermediate driving members, is mounted on the head itself, thus reducing torsional strain by applying the power as close as possible to the cutters. Many other examples might be cited if space permitted.

Examples of Modern Bearing Lubrication

Adequate lubrication of machine tool bearings has become increasingly important, owing to the higher speeds and bearing pressures connected with the high-duty operation of many machine tools. There are, of course, various lubricating systems, all of which operate satisfactorily as applied to different types of machines. In some cases a pump and a centralized supply tank with circulation to the moving parts and back to the pump is used, and in others, the splash system, or possibly an oil-tight case for submerged lubrication is preferable. A few examples will be cited by way of illustrating some of the modern systems.

A heavy engine lathe of 36-inch capacity has a gear-driven pump which delivers oil from a reservoir at the bottom of the head to a distributing chamber in the top cover. The oil passes through a felt filtering pad before entering the bearings and each feed-tube leading to the various bearings has its individual reservoir to prevent one bearing from absorbing the oil intended for another. An overflow from the distributing chamber lubricates the gears, and then the oil drains into a settling basin, from which it overflows into a primary filtering chamber; next it passes through a fine wire mesh filter, and is again pumped to the top of the head.

A rather novel method of lubrication is employed in the case of a polishing machine, the roller bearings of which are made to serve also as oil circulating pumps. Each pair of bearings is so mounted that the larger ends of the tapers are outward. The bottom of each bearing dips into oil in a suitable reservoir, and centrifugal force causes this oil to run to the larger end, from which it is thrown against a deflector plate; the oil then drains back into the reservoir.

An arrangement applied to a universal grinding machine consists of an oil-pump and tank within the base and pipes leading directly to the various mechanisms which are flooded; the oil then returns to the tank. Provision is made for automatically shutting off the flow of oil when the table mechanism is not operating.

In the development of modern machine tools, many interesting designs are found among the special machines. These special types vary from simple hand-controlled machines to fully automatic designs. Such machines may be intended either for one operation only or for more general application. The "semi-single-purpose" type is now regarded favorably for certain operations, especially in the automotive industry. Such machines are designed primarily for a given part, but are so arranged as to readily accommodate different sizes, if this should be required on account of future changes.

A system applied to a heavy-duty radial drilling machine is so arranged that the back-gears and spindle driving gears are lubricated by a pump which receives, from a reservoir, filtered lubricant that passes through a glass sight on top of the head and then cascades down all the gears and bearings, finally returning to the reservoir. The friction clutches and the forward and reverse gears run in a separate oil bath, whereas the spindle and the feed and reverse mechanisms are oiled by a tilted hopper, which is manually operated and distributes a predetermined amount of oil taken from the circulating pump supply.

The lubricating system of a shaper consists of a plunger pump which delivers oil to a sight-feed distributing station on top of the column. As the surplus of oil supplied to the distributing station returns to the pump it floods the main gear bearing and feed mechanism. Feed-pipes, which are supplied with wicks to insure clean oil, lead to various parts of the machine, such as the ram, ram-link and rocker arm.

Automatic control of the flow of cooling compounds or oils, to facilitate reloading and inspection of work, is another feature that is common to certain designs of machine tools. For example, a recent design of internal grinder is so arranged that, on withdrawing the wheel from the work, water is automatically shut off and also turned on when grinding is continued.

Special and Single-purpose Types of Machine Tools

Many of the more interesting developments in the machine tool field pertain to designs that are more or less special. These machines range from "manufacturing types," resembling simplified standard designs of unusual rigidity and power, to machines built specifically for one operation. The semi-single-purpose type of machine is now regarded favorably, particularly for certain operations in the automotive industry. Such machines, while designed for a given part, are arranged to accommodate different sizes, the idea, in some instances, being to care for possible changes in the future. For additional information concerning single-purpose machines as related to the automotive industry, the reader is referred to the articles published in October and December MACHINERY entitled "The Automotive Industry and the Machine Tool Builder."

One of the notable developments in the line of single-purpose machines is represented by the gear-hobbing ma-

chines designed specifically for producing automobile transmission gears. One such machine of simplified design is arranged for cutting gears of only one pitch and one number of teeth, although it may be adapted easily to gears of any other pitch and tooth number within its range. This machine is designed to produce either finished gears or those which are to be ground after heat-treatment.

Another gear-hobbing machine intended for generating gears on a high-production basis preparatory to grinding is so designed that the hob and work are rigidly supported by a housing which arches over the hob- and work-arbors. As this is a single-purpose machine, a selective feed mechanism and special provision for different numbers of teeth are unnecessary. A pair of "pick-off" gears, however, may be changed to vary the feed, and a suitable worm-wheel may be substituted in the drive to the work-arbor to provide for a different tooth number.

A new design of high-duty drilling machine of the "manufacturing type" is provided with only one speed and one feed, although gears can be supplied for a wide range of speeds and feeds if these should be required. This machine, however, is recommended for a single operation on large-quantity production, and it is another example of the modern trend toward the elimination of unnecessary refinement, especially where the machine is designed for continuous use on one class of work.

A study of modern machine tools will show that many improvements have been made in the power-transmitting mechanisms. These developments are related to the design and arrangement of the driving and feeding mechanisms and also to the means of insuring an adequate supply of lubrication. The general introduction of motor drives as integral parts of machine tools has resulted in improved methods of mounting, so as to minimize vibrations and have the motor blend in with the general design. When there is suitable interior space available, it is not uncommon to find the motors installed inside the base.

Examples of Special Machine Tools

Single-purpose machines naturally vary widely in design, since they are to a certain extent, built around their products. Machines of this general class, introduced quite recently, include the following designs, which in some instances are intended for exclusive application to one part, and in others, to a limited range of parts of the same kind but differing in size. A multiple-spindle spline-hobbing machine for hobbing splines on the ends of eight automobile axle shafts simultaneously is an example of the very special machines used in motor car manufacture.

Other single-purpose machines of modern design include a valve finishing machine for automatically reaming and tapping globe valves and similar fittings; a machine designed solely for boring and facing locomotive driving-boxes; fixed-center multiple-spindle drilling and tapping machines, such as are used for drilling crankshafts, etc.; an automatic machine intended especially for finishing automobile hub forgings; a machine for drilling king bolt holes at an angle in front axles of cars equipped with four-wheel brakes; and a two-spindle machine intended primarily for boring locomotive side-rods, but adaptable to other work. The foregoing list is given merely by way of illustrating a few of the specific applications of special machine tools.

Milling machines that are automatic except for loading and unloading might be classed as convertible single-purpose machines, because such machines, when equipped with the proper fixtures, resemble efficient single-purpose types. By the substitution of other fixtures, however, they may readily be applied to the milling of various other parts.

Utilization of Opposed Spindles for End Operations

The plan of using opposed spindles in order to operate simultaneously on both ends of castings or forgings, has been applied to quite a number of the more special machine tools. These machines are highly efficient for handling the general classes of work which come within their range. Ordinarily, the castings or forgings to be operated upon are held in a central fixture located between the work-heads so that internal, external, or end surfaces can be finished at one chucking. One example of the opposed spindle construction is represented by a duplex horizontal drilling machine arranged for drilling, boring, and reaming automobile steering knuckles. A "squirrel cage" type of work-holding fixture is used, and three parts are operated upon simultaneously.

A double-end threading machine of automatic design, which threads both ends of studs simultaneously represents another application of this general principle. The two opposing die-heads receive longitudinal motion from cylinder cams which are changed to suit the threads of different pitch. A double-spindle disk grinder is another illustration of the opposed-spindle construction. According to one arrangement, the fixture which supports the work as it is being ground between the opposed wheels is mounted on a swinging arm that is carefully counterbalanced to insure easy operation. Another double-spindle grinding machine of the ring-wheel type is equipped with a semi-automatic rotary work-feeding device for grinding cast-iron valve sleeve parts. Machines of this general type are not only rapid but also capable of finishing parts within close limits.

A continuous automatic machine of the duplex type with opposed spindle heads has been developed for boring and facing the sleeves of Knight motors. Each of the opposed heads contains six cutter-spindles which are cam-operated. The housings containing the spindles revolve continuously with the work, which is held in proper relation to the cutters by means of clamping levers. This design is an example of a highly specialized single-purpose machine designed for continuous operation on a single part.

Chucking Machines

In the automotive and other large industries connected with the machine-building field, the machining of many castings and forgings on a quantity basis is now being done very effectively in "chucking machines" intended especially for pieces which must be held in some form of chuck. One design of chucking machine of the multiple-spindle type may be equipped with either four or six work-spindles. These machines are intended primarily for forgings and castings requiring facing, forming, and possibly drilling and reaming operations. This machine has an air control which disengages the drive and applies a brake to stop the spindle rotation quickly whenever the work-spindle is indexed to the loading position. This control also actuates the mechanism for releasing the work. The time in which the spindle is stopped is within the operator's control. On a four-spindle machine there are four tool stations on the longitudinal cross-slides, one on the front cross-slide, and two on the rear cross-slide.

Another chucking machine of four-spindle design has automatic chucks which may be actuated either pneumatically or mechanically. The spindles stop automatically for loading in successive order, three continuing to revolve while one is stationary. As soon as the spindle stops at the lower rear position, the work is automatically released. The spindle then remains stationary long enough to permit reloading the chuck, after which spindle rotation continues and indexing occurs.

Examples of Grinding Machine Construction

Owing to the importance of grinding in connection with interchangeable manufacture, firms specializing in machines of this class have made notable progress in placing grinding processes on a highly efficient basis. Many of these developments are related to the construction of unusually powerful and rigid machines which, in common with certain smaller or lighter designs, embody many improvements

related to mechanical details, machine control, and adjustment. The highly efficient grinding wheels now obtainable play, of course, an important part in grinding developments.

An automatic grinding machine intended for cylindrical or tapering parts which can be ground to advantage by the "in-feed" method, represents a recent example of special construction. This machine has a "feeding turret" which receives the work at the front and indexes it to the grinding position at the rear, where centers automatically pick up and drive the part to be ground. The machine is entirely automatic, except when it is considered preferable, for certain classes of work, to feed the turret by hand. This type of machine is applicable to such parts as roller bearings, pistons, piston-pins, bushings, etc.

Another interesting design of grinding machine for wide-wheel grinding has among its special features a reciprocating device for imparting to the wheel a short axial movement in order to maintain an even cutting face and produce a better finish on the work. One of the notable features of this machine is the provision of a continuous power in-feed with twelve rates of feed obtained through an adjustable-speed fractional-horsepower motor. This machine has been designated as a "plunge-cut" type of grinder.

A rotary type of surface grinder, which illustrates present possibilities in the design of large machines of this type, is equipped with a 36-inch wheel and a 60-inch magnetic chuck with an extension ring of 76 inches diameter. The maximum swing is 84 inches and the wheel-head contains a 60-horsepower motor. The total weight of this machine is about 43,000 pounds. Another rotary type of surface grinder designed for work up to 24 inches diameter, is practically automatic with the exception of loading and unloading. The work-carrying spindle swings back about a vertical axis to the loading position. After the work is in the grinding position, engagement of a single lever starts the machine on an automatic cycle in which the work is rotated, the grinding wheel is fed forward, and the coolant automatically delivered through the hollow grinding wheel spindle; finally, the feed is automatically disengaged and the work-head is stopped when the required amount of stock has been removed.

A modern development of great importance, particularly to the users of machine tools, has to do with the standardization of whatever machine tool elements should be uniform to permit using fixtures, chucks, and special tools interchangeably. Present activities in establishing a T-slot standard for the tables of machine tools indicate the practical nature of this work, which, according to present plans, will eventually include other elements common to different makes of machine tools. This important undertaking is one that will ultimately result in considerable benefit to the machine-building industry as a whole.

Centerless grinding, or the grinding of parts without using supporting centers, is one of the more unusual developments which has proved very effective for grinding a large variety of parts, including plain cylindrical parts, such as piston-pins, studs, rods, roller bearings, king bolts, etc., and also shouldered parts, such as push-rods, valve stems, and shackle bolts. Machines of the centerless type have also been utilized effectively for certain form-grinding operations, and new applications are being found constantly. Plain parts are ground by passing them transversely between two opposed abrasive wheels. Work having shoulders is ground by the "straight in" method of feeding.

Several machines have been introduced for grinding the teeth of gears (especially gears for automotive transmissions) in order to correct the slight defects due to heat-treatment. Unfortunately it is not feasible in this review to deal with the principles underlying the design of these machines nor with the important features of different types.

Honing Machines and Lapping Machines

The honing method of finishing automobile cylinders is now employed quite extensively, and several honing appliances have been introduced. This honing process involves the use of abrasive stones which are brought into contact with the previously machined bore, either by a combined rotary and longitudinal motion or by a lengthwise movement. Thus, in some shops the hone is given a fairly rapid rotative motion and a slow lengthwise travel, whereas in others the hone is rotated slowly but is moved rapidly in a lengthwise direction. A third method consists in traversing the hone through the bore without rotation, except at the completion of each stroke, when there is a small but unequal movement. After considerable experimenting, the latter method has been adopted in one well-known automobile plant because it lays the "fuzz or grain" in line with the piston movement.

An interesting special machine, designed for lapping automobile piston-pins or parts of similar shape, is equipped with two lapping wheels between which there is a spider for holding a number of pins in position. In operation, the upper lap is lowered on the pins, and the variation in the lapping wheel speeds causes the pins to rotate and creep slowly in a circular path. There are, in fact, three movements of the pins which insure accurate results.

A lapping machine designed for piston-rings has two cast-iron laps which remain stationary, while a number of rings supported by a work-carrier are given a series of short circular movements combined with a slow rotary motion. The production of precision gage-blocks by mechanical lapping demonstrated the possibilities in this direction, and there will doubtless be further developments.

A special machine recently introduced for polishing automobile crankshaft bearings is known as a lapping machine, although it employs felt polishing wheels which are charged with a fine abrasive. These wheels are of a width to suit the bearings and they rotate at 1500 revolutions per minute while the crankshaft revolves at a much lower speed.

Automatics of Vertical Design

For certain operations in automotive and other plants requiring large-quantity production, the vertical type of automatic machine has been applied quite generally. One of these machines for turning, facing, and grooving parts simultaneously is a six-spindle design, so arranged that a tool-head moves with each work-spindle in a continuous cycle around the machine. As each unit passes the loading position at the front, the work-spindle is stationary, but when rotation automatically continues, the tool-slides feed toward the work, and the movements are all so timed that the part is finished just before it reaches the loading point. This machine is a good example of the specialization in this direction.

Thread-cutting Equipment

Notable developments in equipment for thread-cutting include a thread generator and a thread-hobbing machine, as well as developments in milling and tapping. A machine for generating threads rapidly and accurately on such work as taps, worms, hobs, etc., is provided with a cutter similar to the form used on a helical gear shaper, and the machine operates on the molding-generating principle. Another machine known as a "thread hobbing machine" has two horizontal work-spindles mounted on opposite sides of a large drum, which is indexed automatically at regular intervals to carry an unfinished blank from the front loading position to the rear cutting position and vice versa. The machine is automatic except for loading and unloading. The cutter-head is moved endwise by a lead cam to give the thread the required lead.

One of the recent thread-milling machines is arranged to mill a relieved thread on pipe taps during a single revolution of the tap. Thus the thread-milling operation is supplemented by an additional movement between the cutter and the work to provide the relief.

Owing to the large numbers of drilled and tapped holes required in automotive and other work, considerable attention has been given to the development of automatic tapping machines and combined drilling and tapping machines. One automatic tapping machine of single-spindle design has a twenty-position self-indexing work-table arranged for holding bushings. This work-table has self-closing jaws, so that the operator's work consists merely in keeping the stations filled with blanks. The production ranges up to 25 pieces per minute, depending upon the size and depth of the tapped hole. Another tapping machine which has twelve spindles taps magneto pole pieces at an average rate of 2160 per hour. These figures indicate in a general way some of the possibilities when the quantity of work is large enough to warrant the installation of such highly developed machines.

Since the tap itself is a vital part of a tapping operation, mention should be made of the remarkable results achieved by the use of taps ground by recently developed methods. Properly ground taps are not only accurate as to thread form, lead, and diameter, but have shown marked durability in service. Notable improvements have also been made in cutting tools of other types and in the means for grinding them, but these developments cannot be covered here.

Conclusion

Although this review must necessarily be incomplete, since it is impracticable to refer even briefly to all of the more recent developments in machine tools, with their various improved details and attachments, as well as cutting tools and other auxiliary equipment, (about 350 of these have been described in MACHINERY during the past year) it is evident that the manufacturers of machine-building tools and devices are constantly introducing designs which in many instances represent a vast amount of research and experimenting, as well as large investments of capital. The machine tool industry, as the result of this progressive work, has lowered unit costs throughout the machine-building field, doubtless to a much greater extent than is generally appreciated, but, notwithstanding this fact, many manufacturers still cling to machines or tools of inefficient or obsolete designs when modern types would pay for themselves within a reasonable period. In this connection it is important to bear in mind that machine tool builders in general are specialists not only in the manufacture of the equipment itself but in its practical application, and new or improved equipment is being introduced continually because working tests have demonstrated that the cost of such changes is justified. This point should be considered carefully by manufacturers who delay the installation of new equipment owing to the initial cost. If this condensed summary is the means of stimulating greater interest in the newer and better types of equipment that have been developed, it will have served the intended purpose.

* * *

TAYLOR SOCIETY MEETING

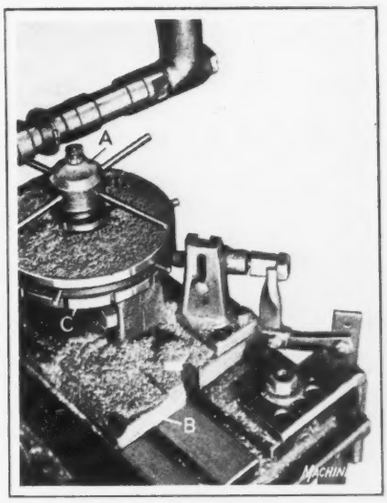
The winter meeting of the Taylor Society was held at the Engineering Society's building, 29 W. 39th St., New York City, December 4 to 6, some of the sessions being joint sessions with the management division of the American Society of Mechanical Engineers. Among the papers read was a representation of Frederick W. Taylor's paper, "Shop Management," by Morris Llewellyn Cooke, of Philadelphia, Pa. Ralph E. Flanders, manager of the Jones & Lamson Machine Co., Springfield, Vt., read a paper on the "Design, Manufacture and Production Control of a Standard Machine." George D. Babcock, of the Holt Mfg. Co., Peoria, Ill., read a paper on "Production Control." Two sessions were arranged for teachers of management, a paper being presented by Joseph W. Roe, professor of industrial engineering, College of Engineering, New York University, on "Content of Courses in Management." A paper covering the same subject was presented by Nathaniel G. Burleigh, professor of industrial organization and management, at the Amos Tuck School of Dartmouth College.

PINION CUTTING ON A HAND MILLER

By DONALD A. HAMPSON

One of the practical methods of manufacturing is to utilize standard machine tools equipped with work-holding fixtures that will enable unskilled workmen to maintain a high production rate. This method is best adapted for work that is run through in comparatively small quantities, or work that is subject to change from year to year. In these fields it holds its own very well, as compared with the single-purpose machine and the full automatic, particularly when the initial investment is added, as it rightly should be, to the more obvious costs of labor, supplies, and overhead.

The accompanying illustration exemplifies this method, showing the job tooled up in a way that holds considerable interest. The work consists of cutting a pinion used in an accessory assembly. The pinion has a threaded stem and meshes with a rack that is part of an adjusting device. The threaded stem of the pinion blank is held in a collet chuck *A* when the gear-cutting operation is performed. The material from which the pinion is made is 0.020 carbon steel, ⅝ inch in diameter. The pinion has thirteen teeth of 24 pitch and a face width of ⅛ inch. The work is put through in lots of from 5000 to 10,000 pieces, it being impracticable to make up larger quantities on account of the screw machine work on the blank which has to be varied slightly to adapt the product to the needs of jobbers in widely separated localities.



Set-up for cutting Pinions on Hand Miller

The work is done on a hand miller with a single involute cutter mounted on the rack arbor. A cast-iron fixture base *B* is bored out and split to receive the indexing fixture, which has a vertical axis. The spindle is in reality a casting with a 6-inch portion which fits into the machined bore in the base. A wide flange on the upper portion of the spindle carries an index-ring *C*. This flange also serves to protect the joint from chips. The large diameter of the spindle increases the rigidity and long life of the revolving member, and the large index-ring insures greater accuracy in the spacing of the teeth.

In the center of the spindle is located the collet *A*, which has a threaded nose-piece provided with capstan handles. This arrangement enables a close concentric grip to be obtained on the threaded stem of the blank without damaging the work. A stop is provided which brings the plane of the gear blank at the same height as the center of the cutter-arbor. The work is fed directly against the cutter and to a depth that is controlled by a stop. The teeth formed in this manner are sufficiently accurate for the intended purpose, and it is not necessary to feed the work past the cutter in the usual manner.

A stop is set for the return movement of the table so that it will not be run back too far. When a pinion is completely cut, a latch can be lifted which permits the table to be run past the stop to a convenient position for reloading. A large index-pin is used, which is connected to a foot-treadle that permits it to be withdrawn quickly. With this arrangement, the workman can keep one hand on the revolving head and the other on the table feed. An average of fifty pinions an hour is produced by an unskilled worker with this equipment.

The Turret Lathe in the Railroad Shop

Tests to Determine the Savings Made Possible by the Use of Turret Lathes in Turning Locomotive Crankpins and Cross-head Pins

THE economies that the turret lathe is capable of effecting in a railroad shop are not generally realized. However, the tests described in this article indicate that the turret lathe may ultimately become as indispensable in a well-equipped railroad shop as it now is in the modern automobile plant. The machining times given for the various locomotive crankpins should be considered as conservative estimates only, since but one pin of each type was machined in each case. This, of course, afforded no opportunity to experiment with higher speeds and feeds, as can be done when a machine is actually employed for production work. The 26-inch Libby high-power turret lathe used in making the tests was a regular stock machine made by the International Machine Tool Co., Indianapolis, Ind.

In some of the illustrations, more tools are shown mounted on the turret than were actually used in making a test. The tabular data for the tests give the time for each operation, and in some cases practically all the essential facts regarding the operation; for instance, referring to the table for the first test, it will be found that in the fifth operation which was that of turning, column 3 gives the diameter to which the part was turned; column 4, the length of the turned surface, and in the succeeding columns the feed, speed, depth of cut, and the time consumed in performing the operation.

The operations for which no speeds, feeds, dimensions of the machined part, etc., are given in the tabular data are of such a nature that it seemed necessary to give a more detailed explanation in the text.

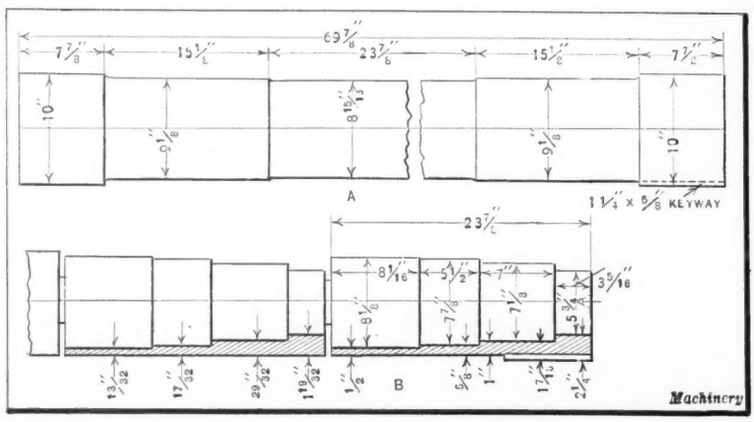


Fig. 1. (A) Old Driving Axle from which the Locomotive Main Crankpin B was machined

The first machining test was made on an old vanadium steel driving axle of the dimensions shown in the upper view, Fig. 1. This axle was obtained from the Nickel Plate Railroad Co.'s Shops, Lima, Ohio, and was not annealed. Two locomotive main crankpins of the dimensions shown in the lower view, Fig. 1, were made from the old driving axle, which weighed approximately 1365 pounds. In the first operation, the axle was centered up in the chuck and all diameters rough-turned. Practically all the information relating to the second operation is contained in the tabular data for Test No. 1. In this operation, one end of the work was supported by a center mounted in the turret head, and the turning tool was held in the toolpost. The third operation was performed with the same tool equipment as the second, after which the turret head was revolved to bring the pointing tool shown at *A*, Fig. 2, into position for the fourth operation, in which the end of the pin was pointed to a diameter of 6 inches, using a hand feed.

Following the pointing of the work, the turret head was revolved to bring the bar turner shown at *B* into the operating position. The toolpost tool was again employed for the sixth operation, after which the box-tool shown at *C* was used for the seventh operation. The eighth and ninth operations were performed by a tool held in the toolpost. In cutting off the pin, the speed was increased as the tool approached the center, the feed being at the rate of 1/128 inch per revolution at all speeds. A spindle speed of 20 revolutions per minute was used at the beginning of the cut, which was

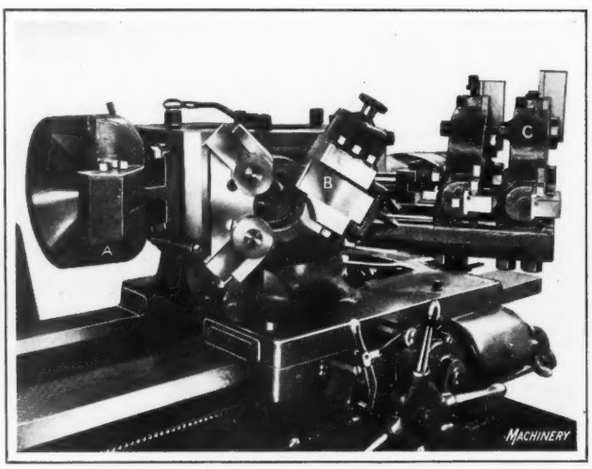


Fig. 2. Turret equipped with Pointing and Box-turning Tools for machining Crankpins

increased to 30, and finally to 45 revolutions per minute. A cradle such as shown at *A*, Fig. 9, which had four supporting rollers and was secured to the turret, was advanced until it reached a position in which it could support the finished pin as soon as it was cut from the bar. From the cradle the pin was removed to the floor by means of a chain hoist. The time actually spent in handling and machining the crankpin during the test, as indicated in the tabular data at the end of the article, was 2 hours and 45 minutes.

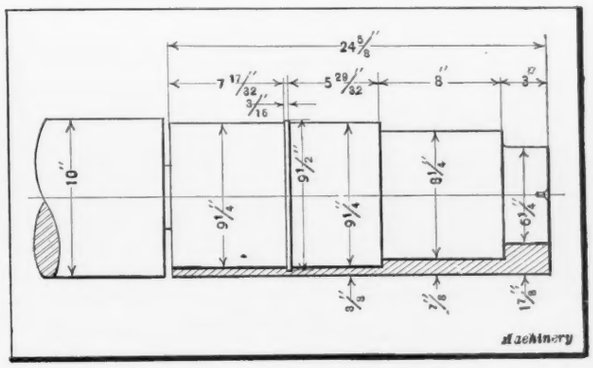


Fig. 3. Crankpin made in Second Test

Second Test

The second test involved the machining of a main crankpin for a locomotive, which was made from a new driving axle 10 inches in diameter and 80 inches long, weighing 1780 pounds. The dimensions of the finished pin are shown in Fig. 3, the amount of metal removed being indicated by the cross-sectioned portion. In this instance, the driving axle was annealed previous to the machining operation. The work was held in the chuck in such a way that it could be centered, rough-turned all over, and cut off without changing its position. The tool used for the second and third operations was held in the toolpost.

In the fourth operation, the tool employed for the third operation continued the cut it had already started, while a box-tool on the turret-head rough-turned another diameter, and the pointing tool then pointed the end of the pin so that the bar turner could be used in the fifth operation. For the latter operation, the turret-head was revolved to bring the bar turner into action, while the cutter in the toolpost took a ⅛-inch cut, 8½ inches long, with a feed of ⅛ inch, at a spindle speed of 13 revolutions per minute, which is equivalent to a surface speed of 34 feet per minute. The bar turner during this time took a cut 1 inch deep and 3 inches long at a feed of 1/64 inch and a spindle speed of 13 revolutions per minute. In the sixth operation, the first pin was cut off in a manner similar to that employed in cutting off the pin shown in Fig. 1. The removal of the finished pin to the floor was also accomplished with a chain hoist. The total handling and machining time—floor to floor—was 1 hour 45 minutes.

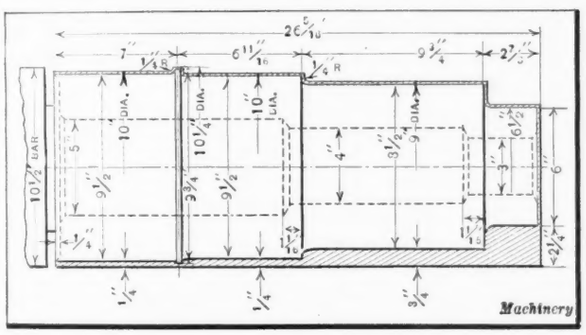


Fig. 4. Crankpin machined in Third Test

Result of Third Test

For the third test, an old driving axle (annealed), 80 inches long and 10½ inches in diameter, furnished by the New York Central Railroad Co., was used to make a locomotive main crankpin of the dimensions given in Fig. 4. In the first operation, the axle was chucked in such a manner that it could be turned and the finished pin cut off without loosening the clamping jaws of the chuck. In the third operation, the 3-inch drill used in the second operation continued to advance until it reached a depth of 14 inches, while a tool held in the toolpost took a cut ⅜ inch deep, 12⅝ inches long, with a feed of 1/32 inch, and a spindle speed of 20 revolutions per minute, which is equivalent to a surface speed of 55 feet. The pointing operation was accomplished with a tool like the one shown at *A*, Fig. 2, after which the bar turner mounted on the turret took the cut indicated in the tabular data.

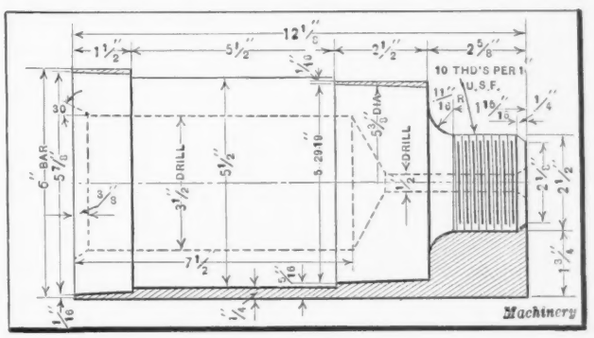


Fig. 5. Cross-head Pin machined in Fourth Test

In the sixth operation, a box-tool on the turret-head, like the one shown at *A*, Fig. 7, rough-turned the 6½- and 9-inch diameters on the work, the total length of the two cuts being 9¾ inches. The cut taken by the first tool was ⅜ inch deep, and that taken by the second tool, ⅛ inch, the spindle speed being 20 revolutions per minute. While the box-tool was in operation, the cutter held in the toolpost took a cut on the remaining length of the piece.

In the seventh operation, the pin was cut off by increasing the spindle speed from 20 to 30 revolutions per minute and finally to 66 revolutions per minute near the end of the cut. The total handling and machining time—floor to floor—on this part was 1 hour 40 minutes.

The fourth test consisted of machining the cross-head pin shown in the diagram Fig. 5, which was made from an old trailer axle furnished by the Altoona Works of the Pennsylvania Railroad System. This axle was 6 inches in diameter and was annealed previous to machining. The axle was held in the chuck shown at *A*, Fig. 8, care being taken to have it extend from the chuck face far enough to

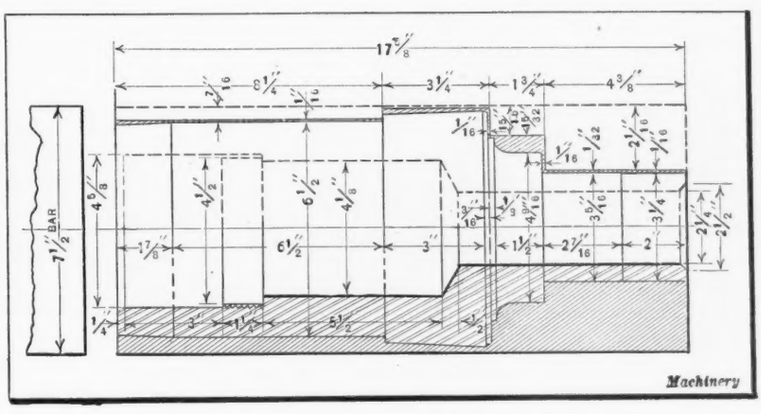


Fig. 6. Cross-head Pin produced in Fifth Test

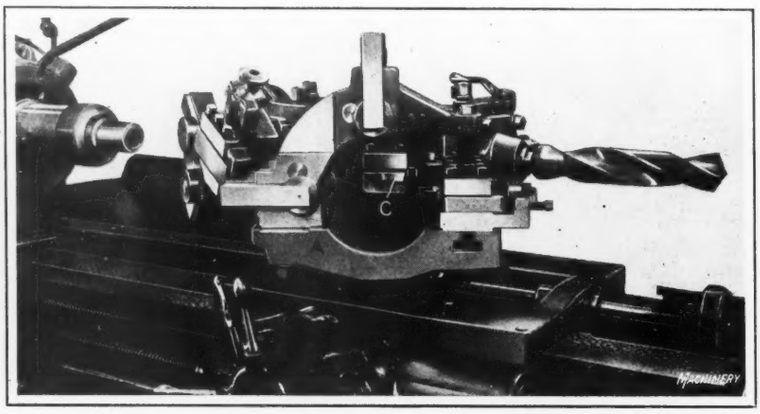


Fig. 7. Turret equipped with Drill and Box-tool for machining Pin shown in Fig. 6

permit the finished pin to be cut off. In the second operation, the projecting end of the work was pointed to a diameter of 3 inches with the pointing tool shown at *B*, Fig. 9.

After the third operation, the pin was rough-turned on the 2½-, 5⅜-, and 5½-inch diameters with a box-tool like the one shown at *A*, Fig. 7. During this turning operation a tool *C*, held in a bar at the rear of the box-tool and working in conjunction with the three turning tools, faced and chamfered the end of the bar. For the fifth operation, the turret was indexed to bring a threading die like the one shown at *C*, Fig. 9, into position for threading the end of the pin. This threading die is of the opening-head type, and was employed at a spindle speed of 9 revolutions per minute.

In the seventh operation, a rack-fed tool mounted on the turret was used to countersink the hole drilled in the previous operation. The cutting-off operation was performed at spindle speeds of 30, 45, and 66 revolutions per minute. After removing the pin from the lathe, it was rechucked and a 3½-inch hole drilled in the large end and the hole countersunk in approximately 8 minutes.

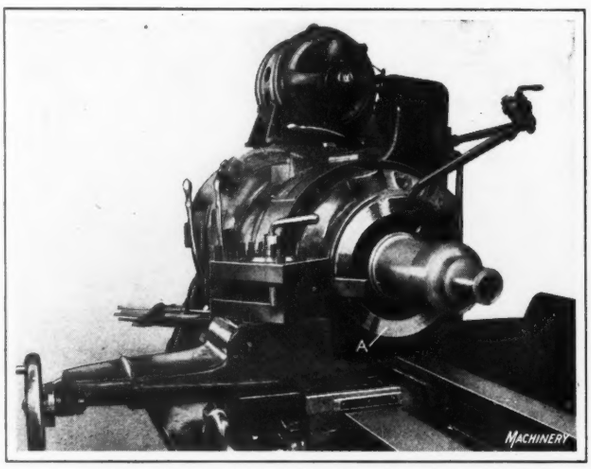


Fig. 8. Cutting-off Tool in Position for cutting off Cross-head Pin held in Chuck

Result of Fifth Test

The cross-head pin shown in Fig. 6 was machined from an old trailer axle 7½ inches in diameter. This axle was annealed before being chucked in the turret lathe. The tool equipment for this pin is illustrated in Figs. 7 to 9, inclusive. After pointing the pin to a diameter of 5½ inches, using a hand feed, the first rough-turning operation was performed as indicated in the tabulated data for the fifth test. In the fifth operation, a 2¼-inch hole was drilled to a depth of 4½ inches with a high-speed drill held in a standard holder mounted on the turret-head, while a 6⅝-inch diameter was rough-turned for a length of 9 inches with a cutter held in the toolpost.

In the seventh operation, the 3⅜- and 7¼-inch diameters were rough-turned with a box-tool mounted on the turret-head. The second tool took a cut ⅛ inch deep for a length of 4⅜ inches at a spindle speed of 30 revolutions per minute. In this case, a bar with a cutter placed in the turret-head, working in conjunction with the box-tool, faced the end of the pin and chamfered the 2¼-inch hole. In the eighth operation, the pin was cut off in a manner similar to that employed in the previous test. The actual handling and machine time—floor to floor—for this pin was exactly 1 hour. The 4⅛- and 4⅝-inch holes at the rear of the pin were drilled and bored, and the thread on the larger hole cut, in about thirty minutes.

* * *

SELLING SERVICE

An interesting example of the service that can be rendered by an organization in conjunction with the sales of its product was recently brought to the editor's attention. A well-known concern which has figured in the development of efficient industrial cleaning methods in almost every line of business, has for fifteen years maintained a clearing house of information about effective cleaning methods, materials, and equipment, and of vital facts pertaining to the operations closely allied to cleaning in industrial plants.

The methods by which this information is gathered and made available to industrial concerns is the interesting point. The company employs about seventy service men who are cleaning specialists and salesmen combined. These men are located in the industrial centers of the United States and Canada, and are serving, in all, at the present time, 18,000 industrial plants. Each of these men reports daily the visits he makes to the cleaning departments in all sorts of plants, and as a result, approximately 150,000 reports are received at the home office annually. These reports describe the results obtained in different plants; they show when costs have been lowered by simplifying or speeding up cleaning operations; and they bring out new ideas about modern equipment and time-saving methods in this field.

At the home office, a staff of engineers and chemists classifies this voluminous mass of data, and in simplified form it is reported back to all the sales and service men in the field, so that each man gets the benefit of the experiences

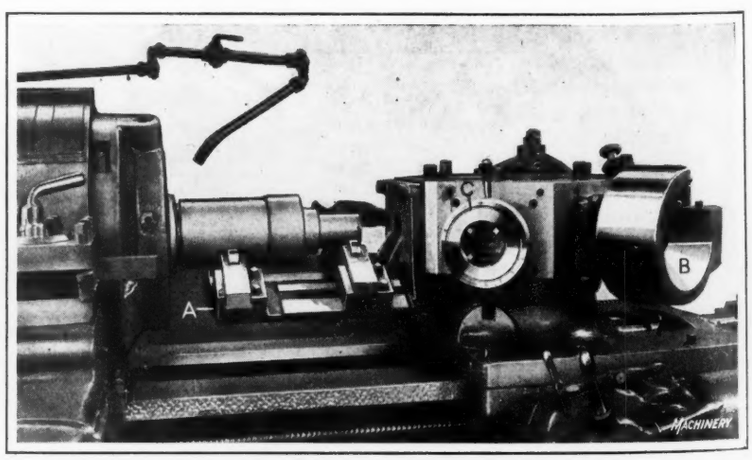


Fig. 9. Turret provided with Cradle for supporting Work as soon as it is cut off

and of the solutions of the problems of every other man. When problems arise that the service man is not able, personally, to solve, the chemical laboratory of the company conducts tests with a view to ascertaining the most efficient methods to be used.

Such an exchange of ideas between sales and service men evidently makes it possible for every man to meet new conditions with greater confidence, and similar methods could be introduced to advantage in many other organizations where now practically each man in the field has to work out his own problems without any direct assistance from other members of the traveling sales and service staff.

In addition to the methods mentioned, every year the entire field organization of the company, together with its technical and laboratory staffs, is brought together in a convention lasting four days. The time is devoted to an intensive and carefully planned study of the problems of the company in introducing and maintaining its service to the industry. Papers of a practical nature are read at these meetings, and each paper is followed by a discussion.

TEST No. 1. TURNING LOCOMOTIVE MAIN CRANKPIN

Number of Operation	Operation	Dimensions of Machined Part		Feed, Inches	Spindle Speed, Revolutions per Minute	Depth of Cut, Inches	Time, Minutes
		Diameter, Inches	Length, Inches				
1	Chuck	...	.....	....	..	.....	8.0
2	Turn	9½	7 7/8	1/32	13	1/4	19.5
3	Turn	8¾	7 7/8	1/32	13	3/8	19.5
4	Point end	6	.....	Hand	..	.....	10.0
5	Turn	6	3 5/16	1/64	13	1 3/8	10.5
6	Turn	8¾	16 3/4	1/16	13	3/16	20.5
7	Turn	5¾, 7⅛, 7⅞	12 1/2	1/64	20	.....	40.0
8	Turn	8⅛	8 3/4	1/32	20	5/16	14.0
9	Cut off	...	.....	....	..	.....	18.0
10	Remove pin	...	.....	....	..	.....	5.0

Total handling and machining time, floor to floor, 165.0

Machinery

TEST No. 2. TURNING LOCOMOTIVE MAIN CRANKPIN

Number of Operation	Operation	Dimensions of Machined Part		Feed, Inches	Spindle Speed, Revolutions per Minute	Depth of Cut, Inches	Time, Minutes
		Diameter, Inches	Length, Inches				
1	Chuck	...	....	....	..	..	16.0
2	Turn	9½	12⅜	1/16	13	¼	15.0
3	Turn	8¼	1	1/16	13	⅝	1.5
4	.....	...	....	....	..	..	32.0
5	.....	...	....	....	..	..	15.0
6	Cut off	...	....	....	..	..	20.5
7	Remove pin	...	....	....	..	..	5.0

Total handling and machining time, floor to floor, 105.0

Machinery

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LARGE THRUST BEARINGS

Five of the largest thrust bearings ever made have been completed by the General Electric Co., Schenectady, N. Y., for five 54,000 kv-a vertical-shaft generators to be installed at the Queenston Station of the Ontario Hydro-Electric Commission. The thrust bearing is 69 inches outside diameter, and is guaranteed to carry a load of 1,000,000 pounds at a normal rotating speed of 187.5 revolutions per minute. The load is made up of the revolving element of the turbine and generator, to which is added the downward thrust of the water. The bearing is capable of supporting the load for one hour at the low speed of 10 revolutions per minute, and also at a runaway speed of 350 revolutions per minute. The thrust bearing is installed at the top of the generator in an oil bath, the latter being cooled by water coils. It consists of a polished rotating steel ring and a babbitt-faced stationary ring, the latter resting on 672 helical springs.

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THE PUMP-BUILDING INDUSTRY IN 1923

The Department of Commerce announces that, according to data collected in the census of manufactures, 1923, there were in that year 229 establishments engaged in building pumps, and these plants reported products valued at approximately $93,000,000, an increase of 33 per cent as compared with 1921, the last preceding census year. Of the plants reporting to the Department of Commerce, 35 were located in California, 29 in Ohio, 26 in New York, 20 in Illinois, 17 in Indiana, 15 in Michigan, and the remainder distributed throughout 25 other states. The average number of wage earners in this industry in 1923 was 14,550, and the wages paid nearly $20,000,000.

TEST No. 3. TURNING LOCOMOTIVE MAIN CRANKPIN

Number of Operation	Operation	Dimensions of Machined Part		Feed, Inches	Spindle Speed, Revolutions per Minute	Depth of Cut, Inches	Time, Minutes
		Diameter, Inches	Length, Inches				
1	Chuck	...	....	....	...	...	15
2	Drill hole	3	6	1/64	100	...	4
3	Drill, turn	...	....	....	...	...	25
4	Point	6¾	....	Hand	...	...	10
5	Turn	6¾	2¾	1/64	20	1½	9
6	.....	...	....	....	...	...	17
7	Cut off	...	....	....	...	...	20

Total handling and machining time, floor to floor, 100

Machinery

TEST No. 4. TURNING LOCOMOTIVE CROSS-HEAD PIN

Number of Operation	Operation	Dimensions of Machined Part		Feed, Inches	Spindle Speed, Revolutions per Minute	Depth of Cut, Inches	Time, Minutes
		Diameter, Inches	Length, Inches				
1	Chuck	...	....	....	...	...	8
2	Point	3	....	....	...	...	8
3	Turn	2¾	2¼	1/64	30	1⅝	5
4	Turn	...	8⅜	....	30	...	5
5	Thread	...	....	....	...	...	2
6	Drill	½	4	1/64	100	...	3
7	Countersink	...	....	....	...	...	1
8	Cut off	...	....	1/128	...	...	8

Total handling and machining time, floor to floor, 40

Machinery

TEST No. 5. TURNING LOCOMOTIVE CROSS-HEAD PIN

Number of Operation	Operation	Dimensions of Machined Part		Feed, Inches	Spindle Speed, Revolutions per Minute	Depth of Cut, Inches	Time, Minutes
		Diameter, Inches	Length, Inches				
1	Chuck	...	....	....	...	...	8
2	Point	5½	....	....	...	...	5
3	Turn	5½	6⅛	1/64	30	1	13
4	Turn	3⅝	4⅜	1/64	45	15/16	7
5	.....	...	....	....	...	...	11
6	Drill	2¼	3½	1/64	100	...	3
7	Turn	...	....	....	...	...	3
8	Cut off	...	....	....	...	...	10

Total handling and machining time, floor to floor, 60

Machinery

The Machine Tool Requirements of Japan

By S. NODA, President, Roku-Roku Shoten, Ltd., Tokio, Japan

THERE are about 3000 machine shops, and 20,000 other industrial factories using machine tools in their repair shops, in Japan. These figures do not include shops and factories that employ less than 10 men each. Of the 3000 machine shops, about 10 per cent may be classified as modern shops, some of which are very large and employ more than 1000 men each. Many of these are equipped with every modern facility. Among the larger concerns in this field are the Shibaura Engineering Works, Kawasaki Dock Yard, Mitsubishi Dock Yard, Mitsubishi Internal Combustion Engine Works, Niigata Iron Works, and Ikegai Works. These firms build a high grade of machinery, and the last two in the list are leading builders of machine tools. The Japanese Government buys exclusively from them. The remaining 90 per cent of the machine shops are mainly small jobbing shops having no specialty, but entering any field that promises a temporary outlet for their product.

Machine Tool Needs of Japan

The 3000 shops mentioned employ about 250,000 men, and approximately 120,000 machine tools are installed in them. In addition, there are the government shops, including navy yards, army arsenals, and the government railway shops, which employ about 140,000 men and in which there are installed approximately 50,000 machine tools. In the repair shops of the 20,000 industrial factories of various kinds, approximately 120,000 machine tools are installed. From this it will be seen that the total number of machine tools now constituting the equipment of Japanese machine shops is somewhat less than 300,000.

If we assume that about one-eighth of this number is required annually for the expansion of the Japanese industry and for replacements, we may assume that there is a yearly demand for approximately 35,000 machine tools, valued at about $10,000,000. Of this amount, past experience shows that machine tools to a value of about $3,000,000 is imported, the remainder—$7,000,000 worth—being of domestic manufacture. About half the machine tools imported, in value, or $1,500,000 worth, has been imported on an average annually from the United States, the remainder coming from England and continental Europe. The machines imported into Japan from the United States are mainly high-grade expensive machine tools, as it is only machines of first-class quality that are bought abroad, the Japanese manufacturers being amply able to take care of the demand for the ordinary run of machine tools.

The importation figures given in the foregoing are based upon the average condition during recent years, but the catastrophe of last year so affected Japanese financial conditions that the exchange rate has fallen 25 per cent below par, and this places a serious check on the import business.

German Competition in the Japanese Field

Since the earthquake, the activity of the German machine tool builders in the Japanese market has been remarkable. The German manufacturers have good connections with long-established resident firms headed by their own countrymen. They have brought to Japan a variety of machine tools which are placed in their showrooms in localities carefully selected in the chief industrial centers of Japan, especially in Tokio and Osaka. The sales are directed by competent sales engineers well equipped with catalogues in the English language. Most of the German salesmen are also well versed in Japanese. As a sales argument, the Germans are using the fact that Japan is converting her weights and measures into the metric system, pointing out that the German machines are built according to this system. The recent reopening of the Siberian railroad for public mail also aids the German trade, because communication with Japan from Germany is much quicker than from the United States.

Prospects for American Machine Tools

Because of the conditions mentioned in the preceding paragraphs, it appears to be rather difficult to increase American imports over those of 1923. The recent action of the Congress of the United States in regard to the restriction of Japanese immigration is also responsible for some adverse feeling on the part of industrial executives, although the educated classes are not generally influenced by these political arguments, and are able to appreciate the motive of the United States and understand the national spirit that dictated the political action. Nevertheless, the European competitors are able to use this argument in their favor.

Recent statistics indicate that about one-fifth of all the machine tools exported from the United States is taken by Japan, and the Japanese market ranks among the most important fields for the export of American machine tools, along with Canada and Great Britain. Comparing the prices per unit of the machines exported to Japan, statistics show that Japan is buying more expensive and high-grade machines than the other countries mentioned—buying, generally speaking, the highest product of the American machine tool industry. In order to further this trade, it is suggested that American machine tool builders make consignments to responsible and reputable Japanese firms that are well versed in the introduction of high-grade machine tools in the Japanese market. This would be an impetus to the selling of American machine tools in Japan, and would help to offset the fact that German and Swiss manufacturers are underquoting in the Japanese market.

Competition with Japanese Machine Tool Builders

The domestic machine tool industry must also be reckoned with as a competitor. The Japanese machine tool manufacturer is gradually coming to the front, but his product is chiefly along the lines of standard machines of a grade that can be sold at a lower price, because the limited market of Japan does not warrant the domestic manufacturer entering the field of highly specialized and high-grade tools.

The fact that German machine tool builders are placing their machines right on the ground, ready for immediate delivery, makes it necessary for competing American machine tool builders to do the same. The writer also believes that a more thorough study on the part of responsible American machine tool manufacturers of the local conditions in the Japanese machine tool market would aid in bringing about closer business relations and increased sales.

Types of Machines Required

As yet Japanese industry has not developed to a point where it can either make full use of, or appreciate, the American single-purpose high-production machine; the machines in general demand are of a more standard type, easily operated. In the lathe field, most people choose the English type of gap lathe, although some prefer the American straight-bed lathe. Universal milling machines, universal grinding machines, and gear-cutting machinery will be in demand. American radial drills are generally considered too expensive for this market, but there is an increasing demand for high-duty all-geared drills. Generally speaking, the market has not yet arrived at the point where it is ready for the multiple-spindle drill.

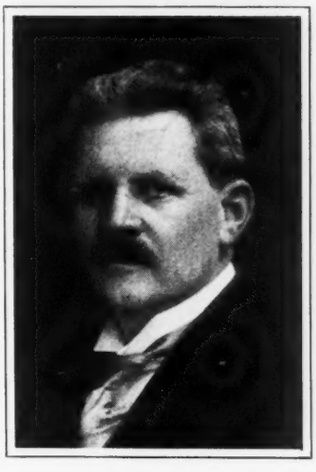
Opinions of Business Leaders

Special Interviews with Prominent Executives in Important Machine-building Industries on the Business Prospects for 1925

FACTORS MAKING FOR BETTER BUSINESS

By CHARLES PIEZ, President, Link-Belt Co., Chicago, Ill.

A review of the last five years shows that the greatest volume of business was done in most industries in 1920; but in many fields 1923 was almost as good a year. The volume of business in 1924 in the fields covered by the Link-Belt Co. was from 20 to 25 per cent less than in 1923, with the first six months of the year considerably better than the latter half. At present, I would estimate the prospects for 1925 to be good, although I am not looking forward to quite the same volume of business as in 1923. Among the factors that will aid in improving business conditions in 1925 are the improved political situation, the ease with which money can be obtained at low interest rates, the prospects for increased central power plant development, the increased demand for agricultural machinery following a higher degree of prosperity in the farming districts, and the improved situation in the coal mining districts.



Henry Harnischfeger

Another factor that makes for improved business is that the results of the election give promise that the railroads will be left alone for several years and will not be affected by adverse legislation. The railroads have done well during the last two years in handling their traffic problems, and are likely to come into the industrial field as important purchasers of equipment, now that public confidence in railroad securities has been restored. If the railroads had continued to be the football of politics during the next four years and if state commissions, instead of the Interstate Commerce Commission, were to have influenced decisions in regard to railroad rates, further financing would have been impossible, because of the lack of public confidence in railroad securities, and the whole industrial and business structure would have suffered.

Now, on the other hand, public confidence in railroad securities is being daily demonstrated. Low interest rates will enable a considerable amount of needed financing to be done, the buying power of the railroads will be greatly increased, and their ability to handle both freight and passenger traffic will be improved, all of which will directly influence the prosperity of all other industries.

Replacement of Old Machinery is Highly Important

The labor situation presents another favorable aspect. Generally speaking, labor has settled down to a more peaceful attitude, and no serious labor disturbances are likely to prevent the activities of the industries during the coming year. Owing to the restriction in immigration, machinery will be used more and more to perform tasks formerly done by manual labor. Business will result from a replacement of obsolete or antiquated equipment with that of a more efficient character. Labor costs are so high that no manufacturer can afford to operate inefficient tools in his shop. Only the most modern tools are able to carry us through periods of keen competition, and the time and the conditions are ripe for a thorough renovation of manufacturing processes and equipment.

Labor will, because of restricted immigration, maintain its present wage rates, and with even a mild boom in business, there is a probability of an increase in these rates and perhaps a shortage in common labor. It is essential, therefore, that all employers view the future with these changed conditions in mind. Increasing the output per man by improved conditions and the addition of machinery is our immediate problem.

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CRANES AND EXCAVATING MACHINERY

By HENRY HARNISCHFEGER, President, Harnischfeger Corporation, (formerly Pawling & Harnischfeger Co.), Milwaukee, Wis.

In referring specifically to the crane business, it might be stated that there was a fair volume in this line of equipment in the early part of 1924. The business fell off considerably during the summer months, but as a result of the recent election there has been evidence of improved conditions. The price situation in the electric crane field, however, is not satisfactory. Competition is extremely keen, and prices are therefore very low—barely enough to pay overhead. Every plant, however, has endeavored to obtain a volume of business at least sufficient to retain a nucleus of the organization and to aid in covering its overhead expenses. There is no doubt that the electric crane business will be better in 1925 than it has been for the last few months, because many buyers have held off placing their orders awaiting the results of the election. Even with a fair volume of business, however, competition in the crane field will be very keen, because there is an excess of plant capacity in this line, and good normal business would not fill all the existing crane-building plants.

As regards excavating machinery, business in this field was very good in 1923 when ours, as well as many other plants in this field, had orders for months ahead. The business fell off in 1924 largely because of the weather conditions both in the East and on the Pacific Coast, which were unfavorable to road-building and excavating work. Generally speaking, there is not a great deal of buying of excavating machinery in the winter, and therefore there is no likelihood of any appreciable volume of business in this field until the spring of 1925, but from that time on there is every reason to believe that there will be a good volume of business, partly because of the delay in road building and excavating work during the present year due to weather conditions, as mentioned, and partly because of the low money rates at which municipalities and states have been able to obtain money for road improvements. In many cases additional bond issues were voted by the electorate at the recent election. There is no appreciable excess of plant capacity in the excavating machinery field, and the normal business in 1925 ought to fill at least the leading plants to capacity.

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DIE-CASTING INDUSTRY

By J. S. GULLBORG
President, Alemite Die Casting & Mfg. Co., Chicago, Ill.

Previous to the war, the die-casting industry had established itself as an important link in the chain of efficient manufacture in the metal-working industries. Several com-

panies were well established in this field, although at that time the castings were generally of simple types and made from white metal alloys. During the war, the die-casting industry developed to a considerable extent because many of the devices required in the equipment of the armies abroad could be more quickly and cheaply made by using die-castings. As a result many new concerns entered the field who did not have the experience or financial backing that the older producers had. These concerns continued to do a profitable business during the brief boom period immediately after the war, and, in fact, during that period other die-casting concerns were tempted to enter the field, because it appeared to them that it was possible to engage in this business with a comparatively small capital and with prospects of high returns on the investment.

These prospects never materialized, because when the depression in business that affected all industries suddenly came upon us in 1920, there were entirely too many people engaged in the making of die-castings for all of them to do a profitable business. The result was a ruinous competition, with price quotations below costs. For nearly four years the industry suffered from a producing capacity far in excess of the demand, with accompanying unhealthy competitive conditions. During this period, however, a great many of the concerns less competent to meet the situation, either because of their lack of experience in the field or their lack of financial stability, were forced out of the business. At the present time the conditions are much more satisfactory, and the industry is beginning to regain its equilibrium and to establish itself on a firmer basis.

J. S. Gullborg

The prospects, therefore, for 1925 are good. More and more complicated shapes are constantly being made by the die-casting process. Complete frames for various devices, for example, with holes cored in every direction, accurately to size, can now be made at a fraction of the cost involved in producing either sand-castings or stampings, provided the quantity to be made is sufficient to warrant the making of dies. When the quantity is large enough to absorb the die cost, there is nothing prohibitive in the expenditure for even a very complicated die, as the most costly dies seldom exceed a thousand dollars for a set, and they are usually good for the production of at least 25,000 castings.

While the making of bronze and brass die-castings cannot be said to have been successful by ordinary die-casting methods, it is now possible to use aluminum or white metal die-castings for ornamental purposes wherever brass and bronze castings would be used simply for the sake of appearances, because the methods of producing finishes on die-castings have been highly developed, and the appearance of bronze, brass, blued sheet metal, and even ebony, bone, and ivory, can be obtained by plating and finishing processes. What are known as brass and bronze die-castings are also made; however, these are not produced by the regular die-casting method, but rather in a type of permanent molds made from non-metallic materials. Only a limited number of pieces can be made in each mold, and the molds must be frequently renewed, which makes the process costly.

It is difficult to estimate the future of the die-casting industry, because of the constantly increasing field for die-castings that is opened up by the ability of the die-casting manufacturer to produce more and more complicated shapes. Whenever the strength of the cast metal permits, many parts can be made cheaper by die-casting than by steel stampings, especially when lugs, finished holes, or any other machining would be required on the stamping. As compared with sand castings, there is no need of elaborating on the advantages of the die-casting, because these have often been pointed out in articles in the technical press.

The development of the die-casting industry will mean increased manufacturing facilities in the progressive plants. This, however, will not place any appreciable demand for new equipment upon other manufacturers, because the machinery used in the die-casting industry, except in the tool-rooms, is of so specialized a nature that it has been developed by each die-casting manufacturer and built in his own shop; the only machinery that he buys from the outside is the regular standard machine tool equipment for tool-room use, and possibly some presses and other machinery used in trimming or finishing the castings, when required.

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THE ELECTRIC TOOL FIELD

By F. W. SINRAM
Treasurer, The Van Dorn Electric Tool Co., Cleveland, Ohio

All that was needed to place this country on a firm business basis was confidence; and confidence has been restored by the results of the election. Money is plentiful for any reputable undertaking and at low interest rates. Manufacturers' inventories are generally low, and stocks in dealers' hands are depleted. All of this spells production for 1925

For electric tools there are two distinct fields—the production field where electric tools are steadily used as shop equipment; and the maintenance field where electric tools are used for repair service intermittently, as in garages, service stations, etc. About 40 per cent of the business in the production field comes from the automotive industry. The remaining 60 per cent comes from railroad car shops, structural shops, woodworking plants, and manufacturing plants in general. In 1924 the volume of business in this field was somewhat limited, because few plants were adding to their equipment and the electric tool manufacturer in the production field had practically the same experience in this respect as the machine tool builder. On an average, the business in 1924 in this line was probably 75 per cent of what it was in 1923.

In the maintenance field, where the customers consist largely of garages and service stations, there has been a constantly increasing volume of business. Every service station and garage is a prospective user of portable electric tools. Until recently sales in this field depended almost wholly upon the first cost of the tool, and as a result many cheap tools were sold. Users had to be educated to the quality idea, and by this time the education has proceeded to a point where leading makers of electric tools are going into this field with a first-class product. The marketing is different from that in the production field, where the sales for the most part have been directly from the manufacturer to the user. In the maintenance field, the sales must pass through jobbers and distributors. In this field, business is likely to grow materially in 1925, but the field must be given a special study to determine exactly what the service shop and garage needs; and then these needs must be met at a price consistent with the quality of the tool and the ability of the buyer to pay.

There is no doubt that there is an over-capacity of manufacturing facilities at the present time in the field producing electric tools, and probably some of the manufacturers will discontinue this line; but at the same time it should be remembered that there is a growing field for the electric portable tool. The advantage of taking the tool to the work, instead of the work to the tool, is creating new possibilities for electric drilling and reaming machines, and new opportunities are opened up for the use of these tools daily. Hence, production of electric tools today, as compared with the demand some few years hence, is undoubtedly quite small, and as the years go on, a material expansion in this industry is likely to take place.

ELEVATING AND CONVEYING MACHINERY

In the elevating and conveying machinery field, the Weller Mfg. Co., Chicago, Ill., states that while the conditions during the first six months of 1924 were quite satisfactory, the business of the last six months was approximately 50 per cent less, and forced most of the plants in this field to run at less than capacity. It is not easy to foretell what the conditions may be in 1925, because in this field every individual installation is built to order and presents an individual engineering problem of its own. But it is safe to say that inasmuch as elevating and conveying equipment is mainly a means for replacing unskilled labor, there must be a constantly increased demand for this kind of equipment so long as the present immigration policy is in force. Our supply of unskilled labor will constantly diminish, and wages for this class of labor will constantly increase; hence, wherever it is possible to use mechanical equipment for doing the work of unskilled labor, such equipment must be installed, and in no field does machinery replace unskilled labor more directly than in the elevating and conveying equipment field.

It is likely that the greatest demand during the coming year in this field will be for cement-handling equipment. New cement plants are constantly being built, and the uses for cement in all fields of civil engineering are growing constantly. There are also good prospects for coal-handling equipment in mines as well as in power plants. The latter handle so much coal that it becomes a matter of economy with them to install efficient labor-saving equipment, and in view of the expansion in the public service power plant field which is already being planned for the coming year, a fair business may be expected from this source. Other fields that offer a fair amount of business are the handling of sand and gravel.

Equipment for grain handling has practically not been in demand for five years past. The grain elevator capacity of the country is probably already too high, and since the installation of concrete grain elevators, permanent in their nature, no new equipment is needed, and all the business obtained from this source is largely in the nature of repairs.

No expansion of manufacturing facilities in the plants making elevating and conveying machinery is likely to take place during 1925, because the present facilities appear to be ample to take care of the business likely to be placed during the coming year. On the other hand, there is no appreciable over-capacity in the manufacturing facilities in this field, and any exceptional demand would necessitate plant extensions and buying of additional machine shop equipment.

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THE METAL-CUTTING STEEL FIELD

By CHARLES M. BROWN
President, Colonial Steel Co., Pittsburg, Pa.

The tool steel field, in as far as it relates to metal-cutting tool steel, depends for its activity directly upon the activity in other metal-working industries. According to present indications, this business in 1925 will be at least as good as in 1923. During 1924 it has been from 35 to 50 per cent less than it was in 1923, although there has been an improvement in the last three months. In addition to the smaller volume, the business has also been much more expensive to carry on, because customers have bought in small lots to their own specifications and required immediate delivery. This has made it necessary for the manufacturers of steel to carry as big stocks as formerly, although the turnover has been very much less.

Charles M. Brown

Two factors will affect the conditions in the metal-cutting steel industry for some time and make it difficult to plan far ahead. These are: (1) Increased use of the electric furnace for remelting and the increasing practice of remelting scrap. This has changed manufacturing methods and the demand for particular qualities of steel, and has thereby upset past trade customs. (2) Increased tendency of consumers to be more rigid in their requirements and to demand methods of inspection that are far more exacting than those of the past. This again leads to changes in manufacturing practices which materially affect costs. These two factors have been mainly responsible for postponing the possibilities for standardization of metal-cutting tool steel specifications. There was a time when it appeared that it would be possible to obtain a set of standardized specifications; but present indications are that such standardization must be postponed to a later date than at one time seemed probable.

There is considerable excess manufacturing capacity in the metal-cutting tool steel field. Manufacturing costs must be reduced in this as well as in all other fields, and those manufacturers who have a definite purpose, integrity, and ability, will remain in business.

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THE WOODWORKING MACHINERY INDUSTRY

By GEORGE C. PURDY
President, Greenlee Bros. & Co., Rockford, Ill.

In the woodworking machinery field in general, the business for 1924 will average from 75 to 80 per cent of the business in 1923. It is anticipated that the business in 1925 will more nearly equal the record of 1923, which was a high one. Since there is ample plant capacity to take care of the greatest demand ever experienced for woodworking machinery, there is no sound reason for any extension of the existing plants during 1925, but there will be a great many machine tool replacements needed in the plants of woodworking machinery manufacturers, if all are to keep abreast of the more efficient producers.

The most important buying of woodworking machinery will come from the factories and mills that are aiming at efficient production regardless of the class of work manufactured. The relative activity in manufacturing woodworking machinery during the last few years is chiefly due to the radical improvements that have been made in many types of such machines and the great economies resulting from their use.

The designing of machines with built-in motors and the universal tendency toward ball-bearing spindles for arbors are the outstanding elements which have brought about extremely high speeds and feeds in operation. The older types of woodworking machines are doomed, and will soon be seen only in those shops where costs are an unknown factor.

The prospects for export trade in woodworking machinery are not very promising, although there is some business to be had in a few countries abroad. It is the domestic field that will provide the main share of the business, especially in the furniture and house-building trades, but the purchases of lumber mills, railroads, and automobile body plants may also be expected to be much heavier than in 1924.

By A. M. MATTISON
President, Mattison Machine Works, Rockford, Ill.

The year 1923 might be considered the first really normal year in the woodworking machinery industry since the beginning of the war. In 1924 business fell off and was about

75 per cent of normal in this field. The outlook for 1925 is good. It is likely to be what ought to be termed a "normal" year, with a volume of business about the same as in 1923. From 60 to 70 per cent of the sales, on an average, represent replacements, the remainder being strictly new or expansion business.

The building of woodworking machinery received no encouragement during the war, being less essential to the conduct of the war than metal-working machinery, but during the last two years the business has improved greatly, mainly on account of the boom in the building industry, which also has had a good effect on the furniture business. There will probably be less building in 1925, but the industries in general are likely to show greater activity and to enter the field as buyers of woodworking machinery.

While the available capacity of the plants making woodworking machinery is greater than before the war, the expansion has not been in excess of the demand of a normal year. In 1923 practically all the woodworking machinery shops had work enough to fill their plants. With the same amount of business in 1925, no expansion of plant capacity should be required, but there will, of course, be the usual continuous replacement of old machine tools with new.

One of the peculiar conditions existing in the woodworking machinery field that is not present, to any extent, in the machine tool field, relates to the disposal of second-hand machines. Most machine tools are sold through dealers, but practically all woodworking machinery is sold directly by the manufacturers; as a result a practice has developed whereby the manufacturers take old woodworking machinery in trade when selling new machines: The best of these second-hand machines are resold, but a good deal is out of date and must be scrapped. The situation is not satisfactory, because the manufacturers get a great deal of money tied up in second-hand machines, and the practice of taking second-hand machines in trade affects the legitimate profits of the manufacturer a great deal more than would price-cutting, bad as the latter practice is.

Owing to the direct selling methods of the woodworking machinery manufacturers, big selling organizations are required. Sometimes manufacturers in other fields look upon the woodworking machinery industry as one that would be satisfactory to enter, but a closer study will show that it is impractical for any manufacturer to enter this field on a small scale, because of the big selling organizations required, due to the practical absence of dealers in woodworking machinery.

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THE MOLDING MACHINE INDUSTRY

By FRANKLIN G. SMITH
President, The Osborne Mfg. Co., Cleveland, Ohio

In the molding machine and foundry supply field, the year 1924 started off well, but business fell off so that the total volume has probably been about 30 per cent less than in 1923. No boom is expected for 1925, but there is every reason to believe that the volume of business will be at least as good as in 1923, and as the improvement during the coming year is likely to be gradual, 1926 should see a still further development. In this industry there is no great overcapacity, although the demand of the country for molding machines has not yet caught up with the capacity for producing, the makers having been somewhat over-optimistic in estimating the demand. In 1923, which may be considered as a normal year, probably 75 per cent of the manufacturing capacity for molding machines was employed.

The different makers of molding machines have not all taken advantage of the opportunity for legitimate cooperation within the industry. A broader vision would materially help the makers of equipment of this kind to place the industry on a healthier foundation. Unwise business methods on the part of some manufacturers have prevented the progress that this industry otherwise might have made.

The greatest development in this field that is now taking place is in foundry sand-treating and conditioning equipment. Here lies probably the largest opportunity for progress in foundry methods at the present time. The use of such equipment has a tendency to produce a better and more uniform quality of molding sand, and by treating the sand, a smaller amount of new sand is needed, and better castings result. As an example of the savings possible with this kind of equipment may be mentioned one case, in which, before the installation of sand-treating and conditioning equipment, 18 per cent of old sand and 82 per cent of new sand was used; after the installation of the equipment, it was possible to use 80 per cent of the old sand and add only 20 per cent of new sand, one foundry alone saving $2000 a month on sand. This, therefore, may well be considered as the outstanding development in this field at the present time.

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THE SEWING MACHINE FIELD

By A. S. RODGERS
President, White Sewing Machine Co., Cleveland, Ohio

The sewing machine industry was seriously hampered during the war. Immediately after the war there was a short upward trend and then a serious reaction set in, which, of course, was felt more by some manufacturers than by others. At that time it became necessary for all the manufacturers to reduce inventories and slow up operations. The beginning of 1922 saw an improvement in this field, and since that time there has been a gradual increase in the volume of business of the entire industry. Taking the case of the White Sewing Machine Co., the business in 1924 was 30 per cent greater than that of 1923; and it is confidently expected that a business approximately 30 per cent greater than that of the past year will be recorded at the end of 1925.

The sewing machine industry—unlike many other fields of machine building—does not depend directly upon prosperous conditions in other industries. There is frequently an active business in sewing machines when there are trade depressions in other fields, because the sewing machine occupies an entirely different position from the general lines of industrial machinery. Food, clothing, and shelter are the prime necessities of life, and the sewing machine is so closely tied up with the second of these that it may well be considered as a necessity of modern life. At the present time, the greatest demand is for electrically driven sewing machines, which so greatly appeal to purchasers that 75 per cent of the sales represent machines of this kind. It has been found advantageous for this company to develop and build its own motors for sewing machines in order to obtain a motor designed exclusively for this purpose; such a motor has to have a number of characteristics, including that of appearance, wherein it differs from the regular line of industrial motors.

The opportunities in the sewing machine field are both for replacement business and for entirely new business. The average life of a sewing machine is fifteen years, and with good care it should last from eighteen to twenty years. This means that from 5 to 7 per cent of all sewing machines in existence must be replaced annually. In addition, there is considerable new business, especially since the makers of sewing machine have developed various kinds of attractive furniture in which sewing machines are placed or mounted, a departure which has greatly aided sales and makes it an industry promising a continuous growth.

This growth of the industry naturally will require increased manufacturing facilities. Many of the machines used in the shops manufacturing sewing machines and the electric motors used for them are of the single-purpose type, of which a large proportion are built in the plants themselves. There are also, of course, a great number of standard machine tools employed—equipment that is regularly bought in the trade. As a whole, the sewing machine industry is to a large extent self-contained, having provided itself with equipment for manufacturing practically all the different items that enter into the product.

ELECTRICAL MANUFACTURING FIELD

By MAX W. BABB
Vice-president, Allis-Chalmers Mfg. Co., Milwaukee, Wis.

In discussing the prospects in the electrical manufacturing field, it might be said at the outset that as the orders placed on the books during the latter part of 1924 were hardly up to normal, the output of the shops during the early part of 1925 in the plants manufacturing heavy electrical machinery will probably be somewhat reduced. There is no doubt that there was a holding up in the placing of orders during the fall months this year due, at least in part, to uncertainty in regard to the election. Now that this uncertainty is over, there is good reason to believe that there will be an increase in business during the early part of 1925, especially as many public service companies have issued bonds recently with a view to plant extensions.

The tendency in the electrical power plant field is toward larger units, because of the possibility of producing cheaper power by the higher efficiency obtained. In localities where electric power is cheap, there is a constantly increasing industrial and domestic demand for electricity, and this, in turn, enables the power-producing companies to increase their capacities and thereby further reduce the cost of producing power. All this tends to create a favorable outlook in the electric power plant equipment field.

Concerning the other types of equipment on which the Allis-Chalmers Mfg. Co. mainly concentrates, we find the business prospects for hydro-electric equipment, steam turbines, and cement and crushing machinery good, while the outlook in mining machinery and pumping engines is for a more quiet year.

In view of the fact that the full plant capacity was not required by the company for its 1924 business, it is not likely that any plant extensions will be needed for the increased volume of business expected in 1925, as present facilities will adequately take care of this demand.

By HENRY D. SHUTE
Vice-president, Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.

In those electrical fields in which our company is a factor, it is my belief that in general the business in 1924 has been from 15 to 20 per cent below that of 1923. In this statement, of course, I except the radio field, where the growth in 1924 has been very great.

As to the business in 1925, I believe that, in volume, it will regain the entire drop suffered in 1924, and that it may be even greater than the business in 1923. The industrial fields that are likely to be the biggest buyers of electrical equipment are difficult to define, as business will probably be spread rather evenly over the entire range of industries. Extensive additions to our various plants were begun a year or so ago, so that no further extensions of major importance are contemplated during 1925, although there will be, as always, minor additions from time to time.

* * *

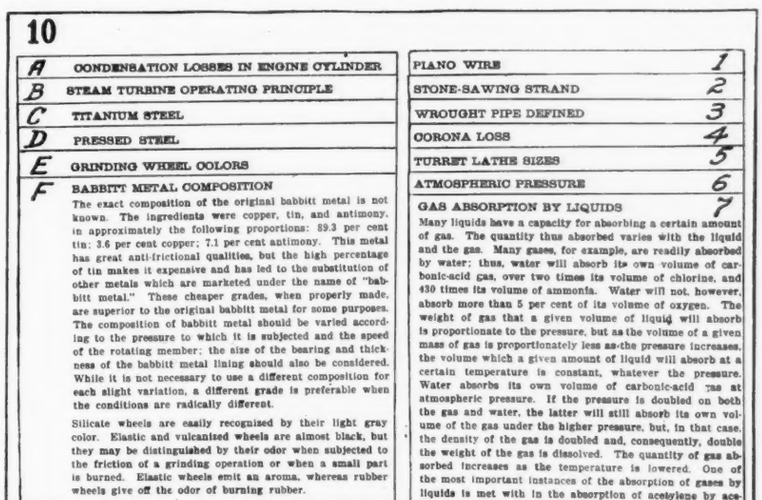
Pig iron production is increasing, and there was a net gain of 23 blast furnaces during November, making 205 active furnaces on December 1.

CONSERVING SCRAP-BOOK SPACE

By JIM HENDERSON

Many mechanics, and others interested in trade developments and shop practice, will probably appreciate the idea outlined in this article on the method of pasting material in a scrap-book for ready reference. When a person consistently follows out the practice of keeping articles in this manner, the accumulation of data makes it difficult in some instances to locate certain material quickly. The usual method is to cut the data from the paper in which it originally appears and place it on a page of the scrap-book with the entire subject matter exposed to view. When a considerable quantity of material is preserved in this way, the available space in the scrap-book is soon covered, and data on the same or related subjects become more or less scattered throughout the book.

To overcome this objectionable feature, the writer adopted the idea here illustrated. Individual pages or sections of the book are devoted to specific subjects or phases of shop practice, and whenever data suitable for the purpose is found in technical papers or catalogues it is extracted and pasted in the scrap-book in either one of two ways—by the lower edge, as shown at the right, or by the margin, as shown at the left, securing about ¼ inch of the clipping to the page and allowing the remainder to swing free. In placing articles of this nature in the scrap-book, begin at the top and work down. When no margin is preserved and the lower edge is used for pasting, it is necessary to use the shorter articles first. When the margin is used for fastening, the length of the article is immaterial, but better results are obtained when the longest articles are underneath.


10
A CONDENSATION LOSSES IN ENGINE CYLINDER
B STEAM TURBINE OPERATING PRINCIPLE
C TITANIUM STEEL
D PRESSED STEEL
E GRINDING WHEEL COLORS
F BABBITT METAL COMPOSITION
The exact composition of the original babbitt metal is not known. The ingredients were copper, tin, and antimony, in approximately the following proportions: 89.3 per cent tin; 3.6 per cent copper; 7.1 per cent antimony. This metal has great anti-frictional qualities, but the high percentage of tin makes it expensive and has led to the substitution of other metals which are marketed under the name of "babbitt metal." These cheaper grades, when properly made, are superior to the original babbitt metal for some purposes. The composition of babbitt metal should be varied according to the pressure to which it is subjected and the speed of the rotating member; the size of the bearing and thickness of the babbitt metal lining should also be considered. While it is not necessary to use a different composition for each slight variation, a different grade is preferable when the conditions are radically different.
Silicate wheels are easily recognised by their light gray color. Elastic and vulcanized wheels are almost black, but they may be distinguished by their odor when subjected to the friction of a grinding operation or when a small part is burned. Elastic wheels emit an aroma, whereas rubber wheels give off the odor of burning rubber.
so designing the engine that expansion occurs in two or more stages as in compound and triple-expansion engines.
PIANO WIRE 1
STONE-SAWING STRAND 2
WROUGHT PIPE DEFINED 3
CORONA LOSS 4
TURRET LATHE SIZES 5
ATMOSPHERIC PRESSURE 6
GAS ABSORPTION BY LIQUIDS 7
Many liquids have a capacity for absorbing a certain amount of gas. The quantity thus absorbed varies with the liquid and the gas. Many gases, for example, are readily absorbed by water; thus, water will absorb its own volume of carbonic-acid gas, over two times its volume of chlorine, and 430 times its volume of ammonia. Water will not, however, absorb more than 5 per cent of its volume of oxygen. The weight of gas that a given volume of liquid will absorb is proportionate to the pressure, but as the volume of a given mass of gas is proportionately less as the pressure increases, the volume which a given amount of liquid will absorb at a certain temperature is constant, whatever the pressure. Water absorbs its own volume of carbonic-acid gas at atmospheric pressure. If the pressure is doubled on both the gas and water, the latter will still absorb its own volume of the gas under the higher pressure, but, in that case, the density of the gas is doubled and, consequently, double the weight of the gas is dissolved. The quantity of gas absorbed increases as the temperature is lowered. One of the most important instances of the absorption of gases by liquids is met with in the absorption of acetylene by acetone; the latter liquid absorbs, at 60 degrees F. and 180 pounds pressure per square inch, 300 volumes of acetylene gas. This property of acetone makes it possible to safely store and transport acetylene gas in steel containers.

Arrangement of Clippings in Scrap-book

In either case—with the exception of the last placed article—the only part exposed is the title, which is usually sufficient for reference, as it is an easy matter to turn over the sheets on top of the article to be referred to, in order to read the full text. In this way a large amount of related reading matter can be placed on one page of the scrap-book and in a manner that makes it an easy matter to refer to the different items.

Indexing is simplified when one page is devoted exclusively to a specific subject, but when not classified, as shown in the illustration, the reference index would be arranged alphabetically in the usual manner with columns at the right of the indexed subjects for the page number and the letter which designates the item or subject.

* * *

SHOCK ABSORBER COMPETITION

Announcement has been made that the City of Paris and the Department of the Seine will offer prizes for the most satisfactory shock absorbers for automobiles available. It is understood that the contest is open to Americans and that prizes totalling 50,000 francs will be awarded. The entries must be made before March 31, 1925, although the tests will not begin until October 1, 1925. Those interested may obtain further information by addressing Direction des Travaux de Paris, Secretariat, Bureau 121, 98 Quai de la Rappee, Paris, France.

Current Editorial Comment

in the Machine-building and Kindred Industries

LOOKING AHEAD

The plans for 1925 of many progressive concerns in the machinery industries, as outlined in the articles by prominent executives in this number of MACHINERY, show that business confidence has been thoroughly restored and that we are entering upon a period of healthy business activity. No boom is expected—no boom is wanted. American business men have learned that boom periods are likely eventual ly to prove as disastrous to a healthy business development as are business depressions; but we are entering upon a cycle of activity which the word "normal" will probably describe more accurately than any period for the past twelve years.

Money is abundant and at reasonable interest rates; stocks, both manufacturers' and dealers', are reduced to low levels; employment is increasing at good wages, and with it the purchasing power of the entire population; the farmer is in a better financial position and will again become an important buyer; the railroads will not be threatened for some years by ill-considered legislation, and are planning important improvements in many directions; the ever-increasing use of electricity insures great development in that field, both for manufacturing and domestic purposes; and the increased activity in other machine-building fields will create a demand for up-to-date equipment to replace the inefficient machine tools found in many shops.

* * *

THE ECONOMICAL ELECTRIC TRUCK

In automobile and other big industrial plants producing large quantities of small or medium sized parts, the electric truck has become indispensable for transportation between the manufacturing and assembling steps. One instance was recently noted where an electric truck eliminated the labor of four men in removing small malleable iron castings from a box car to a storage yard, and reduced the handling time two-thirds. Under the former method a crew of eight men loaded approximately 1000 pounds of castings on a flat truck, pushed the truck to the yard, and dumped the castings on the ground. When a heavy-duty elevating-platform truck was purchased for this work, storage bins were erected and a ramp built over them. Now, the truck picks up a skid loaded in the box car with 2500 pounds of castings, transports it through the yard and up the ramp, and dumps the contents into the bins.

When hand trucking was relied upon in large plants, aisles became clogged with men and trucks, and production schedules were frequently upset because machines stood idle waiting for parts to work on. Electric trucking systems have been profitably installed also in smaller plants, but many still employ the old handling methods, with a considerable loss in time and labor.

* * *

MODIFIED INSPECTION METHODS

In the development of manufacturing methods sometimes a new idea is applied so inflexibly that a reaction takes place and an entire change in methods is needed. Such a condition occurs frequently in the application of inspection systems. Mass production requires a careful inspection of all work to insure that all parts will be made within the prescribed limits of accuracy. The former method of allowing the foremen to inspect and to be responsible for the work passing from their departments was discarded, and inspectors were employed who were not directly connected with any manufacturing department, but passed upon the work after it had been machined, and merely accepted or rejected the parts in accordance with the limits of accuracy.

But a defect in this system became apparent. The inspector passed on the work in large lots after it had been completed, and sometimes hundreds of pieces were rejected on account of an error made in the machining; the work having been performed on all of them, both labor and material was wasted. Gradual modifications, therefore, have been made in the inspection system in many large plants, and the foremen again have been made the chief inspectors for the work passing through their departments, responsible for losses caused by rejected material. They naturally do their utmost to prevent faulty work from being produced and usually detect errors before the operator has begun to produce in quantity.

The system of inspection that followed the development of mass production tended to remove individual responsibility from both foremen and operators, placing all the responsibility upon the inspector. At present there is a tendency to return to a system of more individual responsibility accompanied by less system and red tape. One large concern manufacturing automotive engines found it possible to save a sufficient amount of money by this change in inspection methods to pay for a higher grade of foremen.

* * *

A MECHANICAL TUG-OF-WAR

The development in machine tools and cutting tools has created a kind of tug-of-war between the manufacturers of each. First, we had the ordinary carbon steel tools and machine tools strong enough to resist all the stresses placed upon them by the work that these cutting tools could perform. Then came the Mushet steels, placing heavier requirements upon machine tools, and still later the regular high-speed steel tools which entirely revolutionized the design of machine tools, making it necessary to increase their weight and strength so as to withstand the heavy stresses produced when high-speed steel tools were used to their capacity. Still later appeared special cutting material, such as stellite, Chesterfield metal and others in their class, capable of removing metal at a still higher rate, and demanding still heavier machine tools. At the present stage of the contest, the very latest machine tools are strong enough to drive any cutting tool to the limit of its capacity, and if we are to have more powerful machine tools we shall need cutting tools with an edge that will stand up under more severe service than those now available. Materials for such cutting tools will doubtless be forthcoming.

And so the tug-of-war goes on, with the result that production costs are continually being reduced and all users of industrial products are being benefited.

* * *

GOOD WISHES FOR A FRIEND

Matthew J. O'Neill, for many years general manager of MACHINERY, has become connected in a similar capacity with the *American Printer*, for which well-known journal his energy and ability will soon produce results in the form of increased value and prestige.

The good wishes of all Mr. O'Neill's former associates follow him into a field where he will find many tasks to his liking, and none so arduous that he cannot enjoy life according to his merits.

The Business Outlook in the Machinery Field

Summary of the Opinions of Chief Executives in All Branches of the Industry

TO forecast business conditions is not an easy matter; and yet no business can be successfully managed without carefully laid plans based upon an estimate of future prospects. Hence, every executive responsible for the successful management of a business must make an estimate in his own mind of what the future is likely to be, and a summary of these opinions may be assumed to be quite an accurate indication of what may be expected.

Scope of MACHINERY'S Investigation

MACHINERY has asked more than six hundred of the foremost leaders in every branch of the machine-building industry for their opinions in regard to the future of business during the coming year, based upon their own plans. This inquiry has extended over a very broad field and covers agricultural machinery and implements; automobiles; motor trucks; motorcycles; tractors; fire engines; airplanes; ball bearings; bolts and nuts; bolt and nut machinery; calculating and adding machines; clocks and watches; cotton-ginning machinery; die-castings; cranes; electrical machinery; elevating and conveying equipment; excavating and road-building machinery; foundry equipment and foundries; gas engines; automotive and industrial gears; hardware of different kinds; hydraulic presses and machinery; industrial trucks and tractors; laundry and washing machinery; locomotives; machine tools; metal trim, moldings and doors; mining machinery; paper machinery; pipe, pipe fittings and valves; plumbing equipment; pneumatic tools; power plant equipment; power transmission machinery and equipment; printing plant machinery; pumps for different purposes; railroad supplies; safety razors; screw machine products; sewing machines; sheet-metal stampings; shipbuilding; small tools for machine shop use; steam engines; steam shovels; steel mill machinery and equipment; textile machinery; tobacco machinery; typewriters; water works equipment; and woodworking machinery.

Agricultural Machinery Business is Improving

In the agricultural machinery and implement field, the indications for 1925 are better than for any year since 1921. During 1924, the farm implement industry was occupied to about 50 or 60 per cent of capacity, on an average. Those who obtained a proportionately larger share of the trade were occupied possibly to about two-thirds capacity. The tractor demand improved constantly, and one of the large tractor producers was able to operate his plant practically to capacity. A good tractor business is expected in 1925, and the improved conditions of the farmers are especially encouraging to manufacturers in this field.

Owing to the slack demand in the past, no increased manufacturing capacity will be needed, but competition will be keen, and wherever costs can be cut by the installation of new machine shop equipment, the manufacturers, in view of the improved conditions in the trade, are likely to be interested in replacements. Generally speaking, however, there is not likely to be the replacement business in this field that there will be in some of the other industries, because the machine equipment available has not been used to capacity, nor very steadily, for several years.

An average of the data obtained from a number of leading manufacturers in this field shows that the business in 1924 varied from 70 to 97 per cent of that in 1923; and it is expected that the business in 1925 will at least equal, or be from 10 to 20 per cent better than that of 1923. The export prospects are not very good, although the export business is expected to show a slight increase. Only one of the plow manufacturers refers to the export business as "fair"; and one maker of tractors and threshers as "good."

In the flour mill field, the business of 1923 and 1924 was only 25 per cent of normal. It is expected that this business will be doubled during the coming year. There is not much prospect for export business, except possibly to Mexico and South America. The principal export business in the past has been with the Orient, but this business shows no activity.

The Automobile Industry Expects Steady, Normal Business

The opinions of three leading executives in the automobile field will be found on pages 372 and 373 of this number of MACHINERY. Alfred P. Sloan, Jr., president of the General Motors Corporation, Alvan Macauley, president of the Packard Motor Car Co., and Edward S. Jordan, president of the Jordan Motor Car Co., all express themselves in a very definite way in regard to the healthy state of the industry. A summary of the opinions of a number of other leading automobile manufacturers indicates that the stronger companies, almost without exception, expect in 1925 a business equal to, or from 20 to 35 per cent greater than, that of 1923. Only one of these companies contemplates any appreciable increase in its plant capacity. The prospects for export business are good, and with only two exceptions, the terms used to indicate these prospects are "fair," "good," "exceedingly good," "never better," and "50 per cent better."

In the motor truck industry, an increased output of at least 25 per cent over 1924 is expected, and the export possibilities are considered fair. No plant extensions are contemplated. In the tractor business, an increase of from 15 to 20 per cent over 1924 seems likely, with good prospects both in domestic and foreign trade. The tractor plants gen-

Prospects for 1925

By Julius Klein, Director, Bureau of Foreign and Domestic Commerce

More than six years have passed since the Armistice, and the most difficult problems of readjustment have now been solved. Conditions throughout the country represent a great improvement compared with a year ago and are in sharp contrast to those existing at the end of 1920. While the machinery industry has had a peculiarly difficult experience since the war, it is now clear that the nation can look forward to several years of prosperity. The steel industry, which in large measure creates the demand for new machine tools, is well occupied; the road program, which strongly influences the demand for construction machinery, calls for an extensive mileage this coming year; while the demands for machinery from industry as a whole will probably be greater than they have been for several years. Machinery stocks, in general, are reported to be low, while exports are now running well above pre-war levels and show signs of further increase. Also, conditions are such as to create a demand for larger quantities of labor-saving equipment than ever before.

erally have an over-capacity, and no plant increases are needed in this field.

The motorcycle industry expects about the same business as in 1923, which is a 20 per cent increase over 1924.

The automotive parts business will, of course, depend directly upon the activity in the other automotive fields, but the leading makers of parts, with one exception, are looking forward to an increase in their business of from 10 to 25 per cent, and at least one contemplates a 10 per cent increase of his manufacturing facilities.

The fire engine business is holding its own, there being no expectation of any material change in the output.

The airplane business has fallen off considerably since 1923. One of the leading makers expects that 1925 will show 75 per cent of the output in 1923. The foreign trade possibilities in this field are not good.

The Ball Bearing Industry Expects Growth

In the ball bearing industry, bearings for automobiles and motor trucks naturally follow closely the output of the automotive industry. In industrial bearings, the business in 1924 was practically the same as in 1923, with a marked upward tendency during the last two months. An improvement of from 10 to 15 per cent is expected during the coming year, the increase being mainly in the industrial business, while in the automobile field the output will remain about stationary. No increase in plant capacity is planned, although at least one of the leading concerns in this field will be likely to put in a moderate amount of new equipment, because of the advances that have been made in grinding machinery.

The Bolt and Nut Industry

In the bolt and nut industry, the conditions during the past year have varied considerably, and the prospects also differ according to the plants and their product. Reports on the 1924 business vary all the way from 40 per cent below to 5 per cent above the business of 1923. Some firms expect the business in 1925 to equal that of 1923, while others expect as much as a 25 per cent advance. In this field, there is no expectation of increase in plant capacity. Some of the plants are not engaged in export trade, but those who are, look forward to an improvement.

The bolt and nut machinery business fell off 25 per cent in 1924, but is likely to regain this drop during the present year. Export prospects are good.

Calculating and Adding Machines

In the calculating and adding machine field, business is constantly improving. The volume of business in 1924 with most firms was from 10 to 25 per cent greater than in 1923, only one reporting slightly reduced sales, and the outlook for 1925 is still better, with an increase possibility as high as 40 per cent over 1924. In this field some plants have increased their capacity during the past year, and others will require more capacity, as their present facilities are over-crowded. The export business in this field is good. One calculating machine manufacturer exports 30 per cent of his product, and expects a considerable increase during the coming year. Adding machines have enjoyed good export business during the past year, especially to Sweden, Japan, Canada, and England, with good prospects ahead. In Europe, adding machines are mainly made in Germany, these machines being generally of the calculating machine type.

The Clock and Watch Industry Sees Improvement Ahead

Generally speaking, the business of the clock and watch industry has not differed appreciably in 1924 from the preceding year. A 10 per cent increase in business is looked forward to in 1925 by most manufacturers, and at least one clock company will find it necessary to increase its plant capacity to a proportionate extent. The prospects for export business are not good, but are better than they have been for some time. The pre-war condition in exports has not yet been reached.

Cotton Ginning Machinery

A leading manufacturer of cotton ginning machinery states that the 1924 business was about 25 per cent over that of 1923, and that the volume of business expected during the coming year will be approximately the same as in 1924. The export business has been increasing during the past year, and the export conditions are more favorable than for some time.

Crane Builders Look for Marked Improvement

For the last four years, the business in electric overhead, locomotive, and other types of cranes has not been, on an average, more than 50 per cent of what most manufacturers would consider normal. The first six months of this year showed an improvement, but the business fell off again during the summer, gradually regaining its hold after election. The competitive conditions in this field have reduced prices to a minimum, and this, in addition to an over-capacity for production, has created a difficult situation. Several manufacturers did not produce more than 80 per cent of their 1923 output during the past year, but the prospects for the coming year are favorable, and some concerns expect to nearly double their past year's business in 1925.

Electrical Industry is Prosperous

A review of the conditions of the electrical industry, as viewed by Henry D. Shute, vice-president of the Westinghouse Electric & Mfg. Co., and by Max W. Babb, vice-president of the Allis-Chalmers Mfg. Co., will be found on page 355. The prospects in this field are very promising.

Elevating and Conveying Machinery

Except in coal and ash handling equipment and in the grain elevator field, the business in elevating and conveying equipment was in most cases considerably better in 1924 than in 1923, the improvement, according to the statements of different firms, being from 5 to 45 per cent. Two concerns report about the same volume in the two years. The business expected in 1925 is anywhere from 20 to 100 per cent in excess of that in 1923. One concern in this field has approximately doubled its plant capacity during the past year, and another leading concern has plans under way for materially increasing its capacity in 1926. In coal and ash handling equipment, the 1924 business did not reach more than about two-thirds of the 1923 figures, but the prospects for the coming year indicate an increase of at least 70 per cent over the last twelve months. One manufacturer of grain handling equipment found 1923 and 1924 about equally good years, with a promise of a 50 per cent increase in 1925.

In the hoisting engine and electric hoist field, one leading manufacturer reports approximately the same business in 1924 as in 1923 with prospects for a steady increase during the coming year. In this field increases in business may require increases in manufacturing facilities. The export prospects are the best since the war.

Excavating and Road Building Machinery

In the excavating machinery field, the volume of business in 1923 was large, and yet, in the case of one large producer at least, it was exceeded in 1924. The prospects for 1925 are good, especially in small steam shovels, in which both the domestic and foreign trade is good. There is a fair export business with South America and India, and dredges are being exported to Japan and Siam. Makers of most classes of road building machinery have found the past year a busy one, with indications that 1925 will be better than or at least equal to 1924. The plant capacity for these classes of machinery is about equal to demand in most cases, but there is no expectation of important plant additions at present.

Foundry Equipment and the Different Foundry Fields

A review of the conditions in the molding machine and foundry equipment field will be found on page 354 of this number of MACHINERY, where Franklin G. Smith, of the

Osborne Mfg. Co., outlines the present conditions and prospects.

In the gray iron foundry field, conditions varied widely during the past year. Many foundries did not have more than 60 per cent of the volume in 1923, while others maintained business in about an equal volume. A considerable improvement is expected in 1925, the estimates varying all the way from 10 to 60 per cent above the 1924 volume. It is not generally expected to exceed the volume in 1923.

Leading foundries in the malleable iron field state that their volume of business in 1924 was from 50 to 70 per cent of the volume in 1923; they do not expect that 1925 will exceed the volume obtained in 1923; possibly it will be 10 per cent less.

The conditions in the die-casting field are outlined on page 351 by J. S. Gullborg, president of the Alemite Die Casting & Mfg. Co. Generally speaking, the volume of business in 1924 in this industry has been from 70 to 80 per cent of the 1923 volume; it is expected that 1925 will show a 10 to 40 per cent improvement over 1924.

Gas Engine Builders Expect Fair Year

The gas engine industry has fair prospects. While the business of some of the gas engine builders did not quite equal the 1923 volume during the past year, the falling off was comparatively slight, and one manufacturer reports a 50 per cent increase. The prospects for 1925 are that business will be from 10 to 25 per cent greater than in 1923. There will be no increase in plant capacity in this field, because some of the largest plants have been running only from one-third to two-thirds of their capacity since 1920. The prospects for export business are not very bright, but they are better than they have been for five years, on account of the more settled conditions abroad.

The Gear Industry

The conditions and prospects in the gear industry are quite completely covered in the articles on this subject on page 369 of this number of MACHINERY, where George L. Markland, Jr., president of the American Gear Manufacturers' Association, and F. W. Sinram, honorary president of the same association, outline the prospects in considerable detail. One of the leading gear manufacturers expects an increase in output during the coming year of almost 100 per cent, but this is an unusual case. The more moderate improvement, as indicated in the articles referred to, is the general consensus of opinion.

The Hardware Field

In the hardware field, the reports vary according to the kind of hardware manufactured. In building hardware, 1923 was an unusually good year, and the business in 1924 was generally 20 per cent less. It is not expected that the business in this line will increase in 1925. In other hardware branches, 1924 was a good year, and 1925 promises to be even better. Stove and range manufacturers had generally a slightly improved business in 1924 and are looking for an increase up to 20 per cent over 1923 during the coming year. Refrigerator business in 1924 about equalled 1923, with a prospect of a 10 to 15 per cent increase in 1925. A leading maker of axes and other edged tools reports full-time operation for two entire years. Although the domestic business fell off considerably in 1924, the export business continued good. The outlook for 1925 is that the export business will be maintained, and that the domestic business will improve.

Cutlery manufacturers report from 90 to 97 per cent volume in 1924 as compared with the preceding year, and expect an improvement of from 10 to 20 per cent during the coming year over the last twelve months. No increase in plant capacity is anticipated.

Hydraulic Presses

A leading builder of hydraulic equipment and special machines for various industries states that the volume of business in 1924 was about the same as in 1923 and that in view of the improvements in the rubber, steel, and other industries, an increase of 25 per cent may be expected next year, which will necessitate an expansion in plant capacity of about 15 per cent. In this field not much export business is expected. With few exceptions, equipment of this kind can be produced at lower cost in most foreign countries, and as it is very heavy, the freight charges are high.

Industrial Trucks and Tractors

Industrial trucks and tractors for the handling of materials have not had more than two-thirds the volume of business in 1924 as compared with that in 1923. In this industry the prospects for 1925 are about similar to those in 1923. The plant capacity is ample and no increases are expected. No appreciable increase in the export business is anticipated.

Laundry and Washing Machine Business

In the laundry machinery field, well-known concerns report 1924 business either equal to or 15 per cent above that of 1923, and a 15 per cent increase is expected for 1925; at least one manufacturer will increase his present plant capacity by 20 per cent. The export business is also promising in this field. One of the largest washing machine manufacturers nearly doubled his business in 1924 and expects to increase his 1925 volume by another 50 per cent. This will require a 75 per cent increase in plant capacity.

The Locomotive-building Field

The locomotive industry, unfortunately, does not share the bright business prospects of so many of the other industrial fields. Compared with the year 1923, the leading plants did not operate at more than from 50 to 60 per cent of capacity, and they do not expect to operate at more than 60 per cent in 1925. It is evident in view of this, that important plant additions will not be required. The greatest factor affecting the locomotive business is whether or not the railroad companies will be permitted to earn a fair return on their present property investments—a return that will enable them to increase their facilities and replace obsolete equipment. No large volume of export trade is expected.

Prospects in the Machine Tool Industry

Machine tool builders making special machines for a given purpose and those who provide their machines with fixtures and tooling equipment for high production, have enjoyed a far better year in 1924 than the makers of standard machines. One manufacturer in this field mentions that there has been a definite change in the attitude of buyers of machine tools during the past year. Price is no longer the only consideration, and the more important machine tool users are willing to pay the price if they are assured of a good machine.

The prospects for the machine tool industry for 1925 are more favorable than for five years past. There are fewer machine tools in stock than at any time since 1920. This applies both to the manufacturers themselves and to the dealers. The railroads have already come into the market for new equipment, and the middle western lines especially have worked out very complete programs for the buying of new machine shop equipment. There being no fear of adverse railroad legislation in the immediate future, it is likely that these programs will be carried out and that the replacement business in many of the railroad shops will be of considerable magnitude. In practically every industry using machine tools, as this review shows, the leaders in the field expect a considerable improvement in business, and there is at present a keener realization of the need for efficient machine tool equipment than there has been in the past.

Leading machine tool builders state that their business in 1924 has varied all the way from 50 to 105 per cent as compared with 1923. The highest percentages are met with in the automatic and gear-cutting machinery fields, and in

some classes of turret lathes. The lower percentages, with some exceptions, relate to planers and drilling machines. The prospects for 1925, as compared with 1923, which was a fair year in the machine tool industry, vary with very few exceptions from 95 to 150 per cent. The highest estimates are found in the gear-cutting machinery field and in high-production machines of the semi-special type. The builders of planers, grinding machines, and power presses, generally, expect about the same business as in 1923. In no case reported would the expected business occupy the entire plant capacity; the estimates as to the plant capacity that would be required vary from 50 to 85 per cent, the average being about two-thirds capacity.

Metal Trim, Moldings and Doors

Leading manufacturers in the field manufacturing metal interior trim, partitions, moldings, and doors, report that business is constantly improving. In 1923, business was fully 50 per cent above that of 1922, and the past year was equal to 1923. An improvement of approximately 10 per cent is expected for the coming year, and at least one leading manufacturer in this field has increased his capacity by adding 25 per cent to his floor space.

The Mining Machinery Field

The demand for metal mining machinery has been as good in 1924 as in 1923, and the year just past may well be considered a normal year. In coal mining machinery, again, there has been a considerable shrinkage in the volume of business. Generally speaking, there is a more active development in labor-saving machinery for mining operations than ever before, because of the shortage of labor that has already made itself felt and that will make itself felt still more in the future, due to our present immigration policy.

Expressing in average percentages the reports obtained from leading manufacturers of mining machinery, the business during the past year has either equalled or been from 12 to 15 per cent greater than the business in 1923, and a 25 per cent increase is expected in 1925, compared with 1923.

Paper Mill Machinery

The outlook in the paper mill machinery field is much better than it has been for the last two or three years. Several orders for paper mill equipment have recently been placed, and some of the largest paper mills will place orders for additional equipment during the year. The builders of paper mill machinery, however, will not have to extend their plants, because some of them have been running to a very limited extent during the past year. One leading manufacturer, for example, had only about 40 per cent of the business in 1924 that he had in 1923, and another, 65 per cent, but the prospects for 1925 are that the business will equal that of 1923.

Printing Plant Machinery

In the printing press machinery field the volume of business of different manufacturers varied materially according to the class of equipment built. With some manufacturers the 1924 volume showed a falling off of 20 per cent, while others report an increase up to 25 per cent. The expectations for 1925 vary from 20 to 50 per cent in excess of 1923. Most of the manufacturers of this class of machinery are equipped with sufficiently large plants to take care of the added business, although one of them, at least, will find it necessary to increase his machine tool equipment sufficiently to take care of the increased production.

Pipe Fittings and Valves

In the pipe fittings and valve field, 1923 was an active year, but the business in 1924 slowed up considerably. At present the prospects are good for 1925. An increase in demand has already set in, and there are no stocks on hand. The industrial demand in 1925 will be especially good, because of both the activities of the industries and their financial status. For many years collections have not been so good as they are now, which indicates that industry has firmly established itself again after the depression. While there are ample manufacturing facilities in this field, there will be a good deal of replacement of machine shop equipment, because there has been very little buying of new equipment for five or six years.

Examining the figures that have been obtained from a number of manufacturers in this field, we find a wide variation in the volume of business in 1924. One manufacturer reports sales 30 per cent greater than in 1923, while others report 22, 17, 12, 10, and 5 per cent less than in 1923. As to the prospects for the coming year, some manufacturers expect to equal the 1923 business, while others look forward to from 10 to 30 per cent increase. Only one of seven leading manufacturers in this field expects to increase his plant capacity, the buildings being already under way.

Plumbing Fixtures

In the plumbing fixture field, the volume of business during the past year has averaged all the way from 60 to 120 per cent of that in 1923, while it is expected that the coming year will equal 1923, or exceed it by 20 per cent. One leading manufacturer, at least, has increased his plant capacity about 50 per cent during the past year, but no further increases are expected in 1925. The encouraging outlook in the building industry for 1925 is the most important factor in this field.

The Pneumatic Tool Industry

In the pneumatic tool field, there is a considerable excess of manufacturing capacity as compared with the normal demand for pneumatic tools. In 1923 when the business must be considered as having reached a normal level, the plants in this field operated at only about 50 per cent of their total capacity. The business in 1924 was considerably less (about 20 per cent), but the prospects for 1925 indicate a year equal or better than 1923. There is considerable industrial development in the Middle West, including building of steel mills, locomotive shops, and car shops; and the demand for pneumatic tools for railroad and steel mill use is especially promising.

Power Transmission Machinery and Equipment

In the power transmission machinery and equipment industry, the business during the past year has been approximately equal to that of 1923—in some cases about 20 per cent less. Present indications are that the 1925 volume will exceed that of 1923, possibly by 20 per cent. There is no need for increased plant capacity in this industry. The prospects for export business are good.

Pumps and Pumping Equipment

Owing to the wide variety of pumps made for different purposes, it is evident that there would be a great variety of opinions in this field. With some manufacturers, the business during the past year has been from 10 to 15 per cent less than in 1923, one extreme case reporting business as 35 per cent below the volume of the previous year. In other cases, the business has equalled that of 1923 and even been up to 15 per cent in excess of it. All manufacturers expect an increase in business during the year ahead, and compared with 1923, the indications are that 1925 will either equal the former year or be from 15 to 25 per cent better. One leading manufacturer expects to increase his plant capacity by 25 per cent.

Screw Machine Products

In the screw machine product field, there was a considerable falling off in business during 1924, and as a whole the business averaged not more than from 40 to 60 per cent of that in 1923. It is expected that 1925 will practically equal 1923. Some plants contemplate installing more modern equipment, and at least one of the larger concerns expects to increase its manufacturing capacity.

Sewing Machines

An outline of the conditions in the sewing machine field is given on page 354 of this number of MACHINERY, where A. S. Rodgers, president of the White Sewing Machine Co., points out the important factors that have a bearing on the prospects in this industry. An average of the information obtained from other sewing machine companies indicates that the business generally during the past year was from 5 to 10 per cent less than in 1923, but that the prospects for the coming year indicate at least 10 or 15 per cent greater business. In general, the manufacturing capacity for sewing machines is ample to care for the demand expected. The export prospects are not very satisfactory. There has been some improvement during the last three months, but the exchange conditions abroad have prevented any appreciable volume of exports of sewing machines manufactured entirely in the United States. The South American countries offer the best market at the present time.

The Shipbuilding Industry

The plant capacity in the shipbuilding industry, as might be expected, is much in excess of the present average of business. Even in 1923, when the business was 20 per cent greater than in 1924, and 30 per cent greater than the expectations for 1925, only 50 per cent of the capacity of the old and well-established shipbuilding concerns was required; and some of the newer concerns that sprang up during the war either have gone out of business or have operated in an extremely limited way. The factors that especially affect the shipbuilding industry are the changes in the naval program, the lack of demand for additional coastwise shipping, and the fact that there has been no legislation to encourage an American merchant marine.

The Small Tool Industry

In the small tool industry, the business in 1924 varied from 30 to 5 per cent less than the business in the preceding year. The prospects for 1925 are better. An increase of from 10 to 25 per cent over the 1923 volume is expected by practically all the leading manufacturers of small tools for machine shop use. Even this increase in business, however, is not sufficient to occupy the full capacity of the plants in this field. Some of the larger plants will require only from 65 to 75 per cent of their manufacturing capacity, there being two exceptions where leaders in one of the small tool lines expect to run 90 per cent of one-shift capacity. The foreign business outlook will doubtless improve materially during 1925, and the prospects for export business are good. Some of the well-known manufacturers expect to export from 10 to 20 per cent of their total product.

Steam Engines and Power Plant Equipment

As compared with 1923, the business in the steam engine field was fairly satisfactory during the past year. Two leading manufacturers report that they had the same volume of business both years; one reports an increase of 25 per cent, as compared with another report of a 10 per cent decrease. The 1925 volume of business is expected to be either equal to or slightly better than that of the two previous years. No increases in plant capacity are likely to be made, but if the present business prospects materialize, old equipment will be replaced.

In the power plant equipment field other than that of steam engines, the conditions during the past year were not so favorable. Reports from concerns engaged in this line of business indicate that the 1924 volume was from 40 to 60 per cent less than in 1923, and the expectations for the coming year are that it will either equal that of 1923 or be slightly less.

Steel and Rolling Mill Equipment

In the rolling mill machine field and generally in the machine-building fields that apply themselves especially to machinery for the iron and steel industry, there was, with few exceptions, a falling off in business during 1924, as compared with the preceding year. Makers of rolling mills expect, however, that business in 1925 will show an improvement of from 10 to 35 per cent over that of 1924.

The Textile Machinery Field

In the textile machinery field the business in 1924 was not very satisfactory. Some plants were running at reduced time with a greatly reduced force. The business fell off considerably from that of 1923. The lines that offer good business during the coming year are the specialized labor-saving textile machines. An average of the figures obtained from the leading builders of textile machinery shows that the business in 1924 was only about 75 per cent of that in 1923. Three of the larger plants, at least, expect to do as much business during the coming year as they did two years ago, and one is contemplating the possibility of increasing its manufacturing capacity about 10 per cent.

The Tobacco Machinery Industry

In the tobacco machinery field, conditions are constantly improving. The volume of business of leading builders of tobacco preparing machines, tobacco cutting machines, and cigarette machines, increased about 10 per cent in 1924, and it is expected to increase another 30 or 40 per cent in 1925. As there have been recent increases in plant equipment, no further increases are expected during the coming year.

The Typewriter Industry

In the typewriter industry, there has not been a great deal of change during the last two years, although the business in 1924 was sightly less than in the preceding year, possibly from 5 to 10 per cent. An increase is expected in 1925 of from 10 to 35 per cent over 1924. There is ample manufacturing capacity in this field, and no plant extensions are contemplated. The export prospects are good and are constantly improving.

The Woodworking Machinery Industry

The prospects in the woodworking machinery industry are concisely summarized in the two statements published on page 353 of this number of MACHINERY by G. C. Purdy, president of Greenlee Bros. & Co., and A. M. Mattison, president of the Mattison Machine Works. An average of the reports obtained from leading woodworking machinery builders shows that the business fell off from 20 to 25 per cent in 1924, as compared with the preceding year. It is expected that in 1925 the volume will at least equal that of 1923. There is no likelihood of any further extension in plant capacity during 1925, but there will be an active business in replacing old equipment with new, and bringing the manufacturing facilities up to date.

Report from Miscellaneous Industrial Fields

Leading manufacturers of fans and blowers not only maintained the 1923 volume of business during the past year, but increased it by nearly 10 per cent, and expect an improvement of 25 per cent, as compared with 1923, during the coming year.

The safety razor industry improved 15 per cent in 1924, and another 15 per cent increase in volume is expected during the coming year.

In railroad supplies, the volume of business in 1924 was about 25 per cent less than during the preceding year, but present favorable conditions indicate that the coming year will regain the position of 1923.

In water works machinery and supplies, there is a constantly increasing volume of business. One manufacturer who specializes in this field had a volume of business 35 per cent greater during the past year than in 1923, and expects to have an increase of 10 per cent in 1925 over 1924. To meet this demand, an increase in plant capacity of about 20 per cent will be made.

Machine Tools—Present and Future

By FRANK A. SCOTT, President, Warner & Swasey Co., Cleveland, Ohio

THE year 1924 was not a good one for the machine tool industry. It was the fourth successive year in which the industry was unable to sell, or manufacture, at even half capacity. The results, when compiled, probably will show that the turnover has not been greater than the 1923 volume. The profits undoubtedly are small, and many companies will probably show losses. However, it does not follow that all the machine tool plants have been reduced to the meager volume represented by the machine tool demand. Many concerns have introduced into their list of products articles of manufacture other than machine tools, and by this means have been able to piece out their production volume to a very helpful extent.

The 1925 Outlook is Much Brighter

There is not room for disagreement on the point that 1925 holds out encouraging prospects for a much better showing than 1924. The reasons are numerous; the presidential campaign is over and there is ample evidence on every hand that business men throughout the entire country are more inclined to make a forward move; European conditions have improved greatly during the year, and before the end of 1924 a modest volume of business had begun to appear from European sources; out of the total quantity of machines produced for war purposes, vast numbers are reaching the end of their usefulness, and must be replaced with new equipment; the railroads enjoyed a good year, and have an even better one in prospect, and this will be reflected in a larger buying program of rolling stock, motive power, and machinery; the railroad equipment companies are sure to be called upon, and their response will necessarily entail some machine tool buying; the business of the farmer improved to a marked degree, with a consequent expansion in the buying power from the agricultural districts in the middle and far west, which will be reflected in a demand on the automotive and agricultural implement manufacturers, as well as in many other lines; the building program is still large; the electrical field promises many new developments, and so on—the list could be extended indefinitely.

The Position of the Second-hand Market

Since 1920 the machine tool industry of the world has been working against a cushion of used machines in the second-hand tool market, and surplus equipment in the war-expanded plants. It is only within the last few months that many manufacturers of American standard machine tools have been able to report that the end of this supply of used machines is in sight. The somewhat increased demands from Europe at the end of 1924 are probably due to this fact.

In certain directions there has been a tendency on the part of big customers to emphasize the price factor. It would be harmful to the users and to the entire metal-working industry to have the first cost of machine tools overemphasized. The increasing complexity of design; of possibilities of cutting materials; of metals to be worked upon, etc., have increased the research duty and opportunity of the machine tool manufacturer. Cut down the price and certainly and quickly will the production be cut down of new and better designs and new and better methods of machining. In such cases the machine tool user is the certain loser. Far better to let the machine tool industry prosper and continue to contribute to the advancement of American metal-working industries.

Machine Tools Cannot be Manufactured in Quantity like Automobiles

It is self-evident that the machine tool industry, in its present stage of development, cannot be a quantity business, as the automotive industry is, or the plumbing supply industry, or electrical or many others. It is less flexible. Its jig and tool costs must be spread over a comparatively small production. This must inevitably create a higher cost per unit. Therefore, the use of standard machines, wherever possible, is in the interest of the producer and the user as well. In many instances in the machine tool industry, construction processes resemble laboratory more than manufacturing processes. This can and does produce a high-grade product by which the user benefits. It is less likely to produce a satisfactory profit for the machine tool builder. Added to this natural limitation, always present in the machine tool business, there has been the pressure during recent years of producing special automatic single-purpose machines, which obviously are a laboratory product.

The Importance of Standardized Machines

For the welfare of the industry, as well as its customers, there must be adherence to standardized types of machines. Standard automatic machines are constantly appearing, adaptable to many kinds and ranges of work; likewise semi-automatics that are even more flexible. These machines have a place in many highly developed plants; they are available for a variety of work by merely changing tools; they are less costly than special automatic machines; they have a respectable second-hand value.

The single-purpose and special automatic is likely to possess a longer life than the job for which it is intended, but its value ends with the job. Standard general-purpose machines and standard automatics and semi-automatics have all been improved during the four years of depression. The trend of the industry will still be toward the improvement and development of standard general-purpose machines and standard automatics intended for certain types of work, but not for particular pieces. The cost of tools; of tool set-ups; production time lost in retooling, setting up, and correcting unforeseen difficulties; and the breaking down of tools under high speeds are among the problems developed by the use of special machines that have mellowed the production engineers toward standard machines.

If the interdependence of the maker and user of machine tools could be still further understood and acted upon, it would be of great mutual benefit. If, first of all, it could be accepted that a machine tool is a production unit and should therefore be priced on quality, productive power, and balanced design and accuracy, much would be gained by both sides. If low earnings in the machine tool industry continue, there is certain to be a loss in the high-grade personnel of the industry. Such a loss would be felt for years. A reduction in the creative power and productive ability of the American machine tool industry would constitute a loss to be shared by every metal-working industry in the land and many others.

* * *

In 1922, eight million tons of paper were consumed in the United States—more than that consumed in all the other countries of the world put together. The United States Department of Agriculture regards the situation of the wood pulp paper supply as serious, because of the constantly decreasing supply of wood.

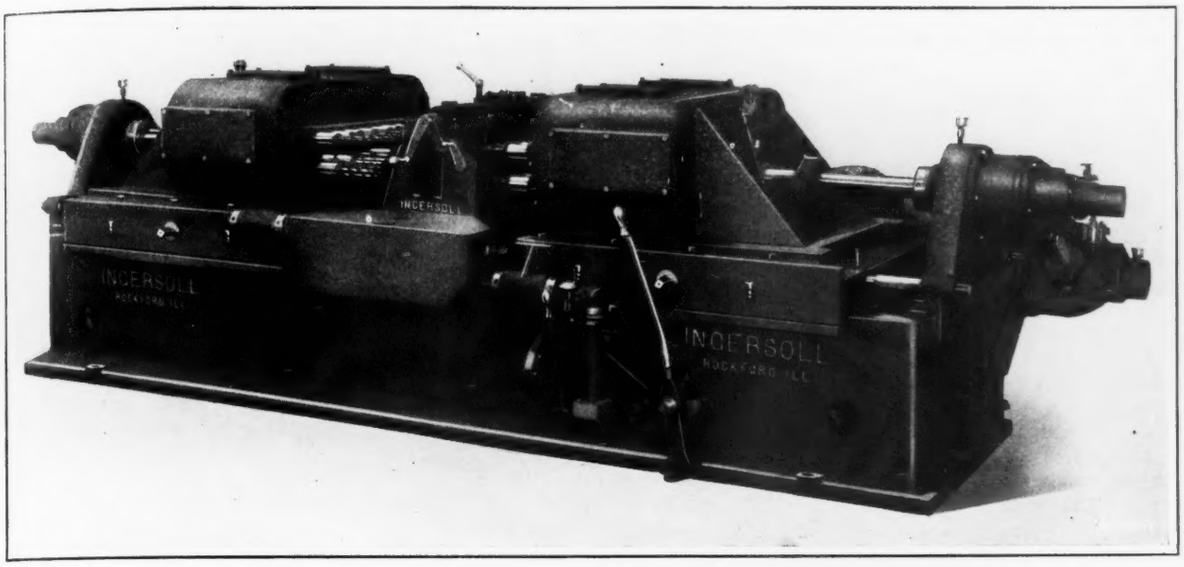


Fig. 1. Two-Way Machine for drilling Fifty-four Holes simultaneously in Opposite Sides of an Automobile Cylinder Head

Increasing Automobile Production with Special Machines

Various Types of Boring and Drilling Machines Designed by the Ingersoll Milling Machine Co. for Automobile Plant Service

MACHINE tools of special design are usually arranged for performing a number of operations on a part simultaneously, and hence they greatly reduce the production time over standard methods. However, for a special machine to be truly economical it must be kept busy; otherwise, considering the overhead costs and other factors, it may be cheaper to perform the operations singly in standard machine tools. Because of the large quantity of parts of the same size and type manufactured in the ordinary automobile plant and the tremendous competition in the automobile industry, it is natural that special machine tools have been more widely adopted by this industry than by any other. During the last few years, the Ingersoll Milling Machine Co., Rockford, Ill., has developed a large number of special machines for performing boring and drilling operations on automobile parts. Some of these machines are described in the following.

Two- and Three-way Drilling Machines

Fifty-four holes are drilled simultaneously on opposite sides of a head for a six-cylinder motor by means of the two-way machine illustrated in Fig. 1. The production averages fifty castings per hour. The machine is semi-automatic, the operator loading and clamping the work in the fixture and then tripping the feed-lever. The saddles have a rapid traverse to the work, feed to the specified depth, pause for counterboring steps, and make a quick return to a stop. Location of the work is obtained from a milled side and bottom, and it is equalized from both ends.

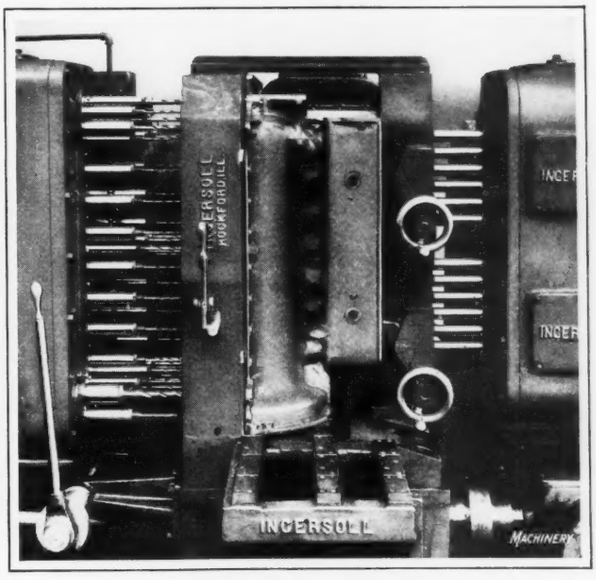


Fig. 2. Method of holding a Six-cylinder Motor Block in a Three-way Horizontal Machine that drills Sixty-one Holes in the Top, Bottom, and Valve Side

Like all the other machines to be described, this one is of box type construction, and all gears are made of steel, hardened, and run in oil. A rotary geared pump is built into each saddle to provide forced-feed lubrication for all bearings. The saddles are mounted on compound slides so that they may be withdrawn sufficiently from the center of the machine to permit changing drills. The drill spindles have fixed center distances. Each one is equipped with an adjustable collet to compensate for wear of the drill. The machine can also be arranged to be operated by hand, and any desired feed can be obtained without affecting the automatic cycle.

A close-up view of a special drilling machine equipped with three heads sliding in a horizontal plane for drilling sixty-one holes in a six-cylinder motor block is shown in Fig. 2. Thirty-eight of these holes are drilled in the bottom of the block, twelve in the top, and eleven in the valve side. All the spindles, in this case also, have fixed center distances. The casting is located on finished surface plates on the base and by means of the main bearing holes. It is clamped against a vertical surface of the fixture. The holes are simultaneously drilled from the left, right, and rear, the production averaging seventeen castings per hour. This machine is driven by a 15-horsepower motor, occupies a floor space of 14 by 9 feet, and weighs about 35,000 pounds.

Another three-way drilling machine in which one head operates vertically is shown in Fig. 3. This machine is equipped with forty-nine fixed-center spindles, arranged for drilling thirty-one holes in

the top, ten holes in the front end, and eight holes in the rear end of the six-cylinder motor block operated on by the machine shown in Fig. 2. The cylinder is located from the main bearing holes and from the lower milled surface. It is then clamped in position by means of the two handwheels shown. When the clutch is thrown in, the saddles feed forward the required distance, and then automatically make a quick return to the neutral point and stop there. This machine produces seventeen cylinder blocks per hour. It is driven by a 25-horsepower motor at the rear, occupies a floor space of 11½ by 7 feet, is 8½ feet high over-all, and weighs about 25,000 pounds.

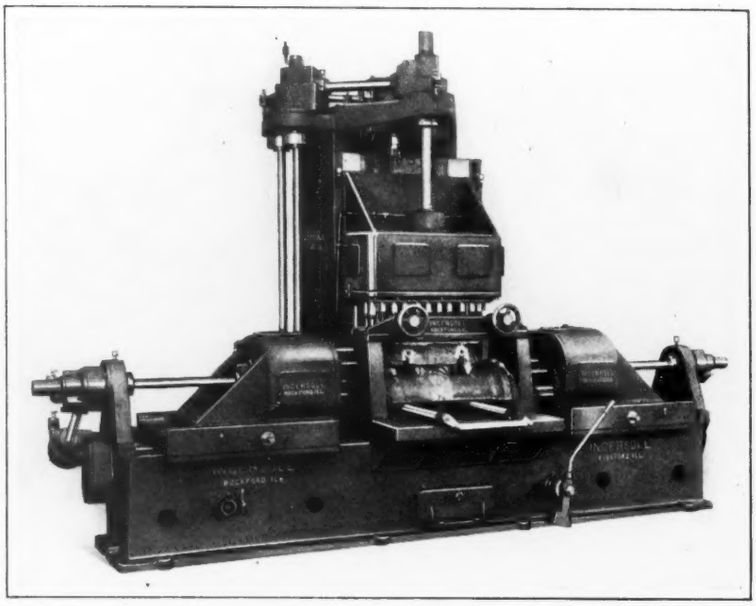


Fig. 3. Three-Way Machine in which Two Heads slide horizontally and One vertically

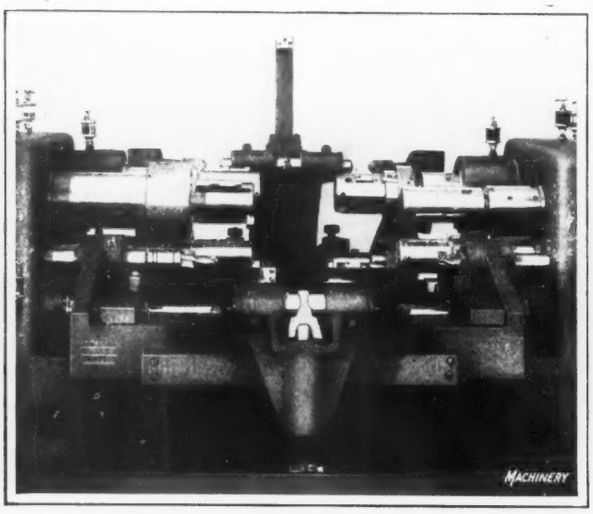


Fig. 4. Tooling provided for a Two-way Horizontal Machine designed for boring Tractor Transmission Cases

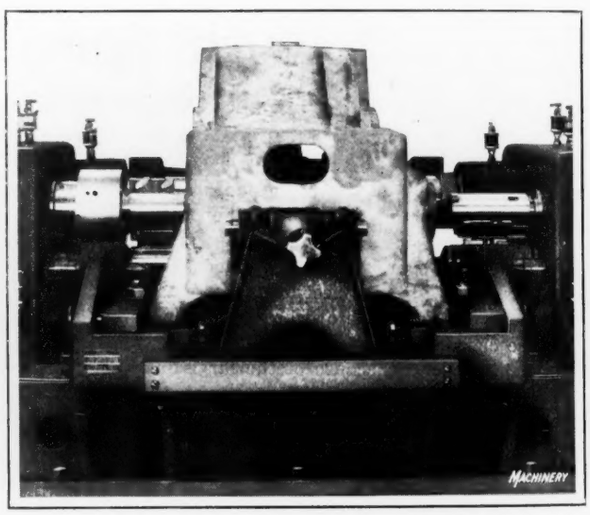


Fig. 5. Another View of the Machine illustrated in Fig. 4 with the Work in Place Ready for the Operation

Front Axle Drilling Machine

A machine developed for drilling the four king-pin holes and eight spring-pad holes in an automobile front axle is shown in Fig. 6. After the operator places the axle in the machine, it is located and clamped from the king-pin bosses in equalizing V-blocks. The king-pin drilling units are then advanced to suit the length of the axle, by rotating the large handwheel which is directly in front of the operator. The equalizing V-blocks are mounted on these drill heads and thus the drills are always centered properly with the bosses of the king-pin holes.

When the starting lever is thrown in, all the drills feed forward to depth and then make a quick return to a stop. One machine can easily drill twenty-eight axles per hour, and there is sufficient time during the drilling for an operator to handle a second machine. The machine occupies a floor space of 6½ by 6 feet, is driven by a 20-horsepower motor, and weighs 19,000 pounds.

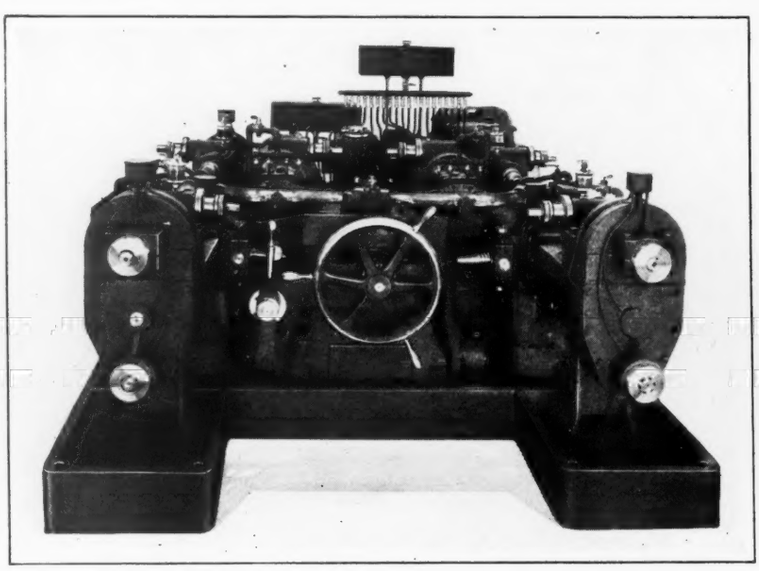


Fig. 6. Machine designed for simultaneously drilling Four King-pin Holes and Eight Spring-pad Holes in an Automobile Front Axle

Cylinder Boring Machines

Cylinder boring machines of the vertical type with inclined spindles have been built with different numbers of spindles for boring cylinder blocks of various types. For

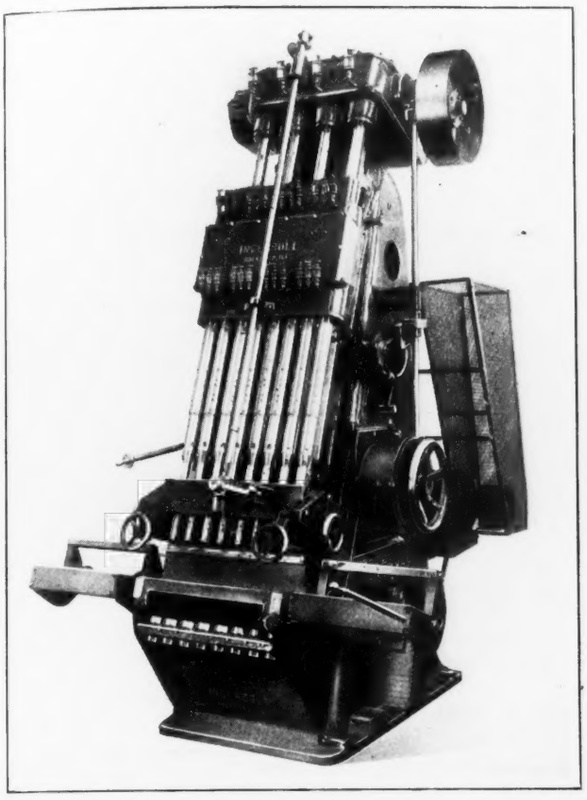


Fig. 7. Inclined Type of Machine designed for boring the Cylinders of an Eight-in-line Motor Block

instance, a four-spindle machine was developed for taking roughing, semi-finishing, finishing, and reaming cuts on the cylinder block of a light-truck engine; a six-spindle machine, for finish-boring the Chrysler cylinder block; and the machine shown in Fig. 7 for finish-boring the cylinder block of a new eight-in-line engine. All of these machines were equipped with Ingersoll boring-bars and their interchangeable block type cutter. It is claimed that the diameter of a hole can be held to limits of 0.0005 inch with these cutters, even though the cutters are changed many times from one bar to another.

The cutter blades are made of high-speed steel and locked in heat-treated alloy steel blocks by hardened taper wedges. The blades are easily adjusted by releasing the wedges. When in use, the cutter blocks are held in slots in the cutter bars by an expanding wedge which permits removing and replacing a block without destroying its accurate location in the bar or impairing the accuracy of the hole bored. On each of the machines mentioned the boring-bars enter lower pilot bushings, such as shown in Fig. 7, before the cut starts and remain in them when the cut is completed, until the tools have been withdrawn from the work. Because of the angular design of the housing, chips fall clear of the lower pilot bushings and the saddle obtains the full support of the ways without relying upon clamps. Extra wide ways are provided to minimize wear and insure long life. The machine shown is equipped with a special fixture designed to suit a conveyor line. There are two counterbalanced cradles which can be aligned with either the fixture base or with the conveyor so that the operator does not need to lift the work into place in the fixture.

One lever conveniently located at the left-hand side of the machine controls both the feed and the power rapid traverse. This lever is tripped automatically at the end of the cut, and when this occurs, all mechanisms return to the neutral point and stop. The different units of any machine of this type are easily accessible, and can be removed without disturbing other units. The rigidity of the machines and the method of piloting the boring-bars makes it possible to use a feed of 1/16 inch per revolution with a cutting speed of 45 feet per minute in roughing or finishing cylinder bores.

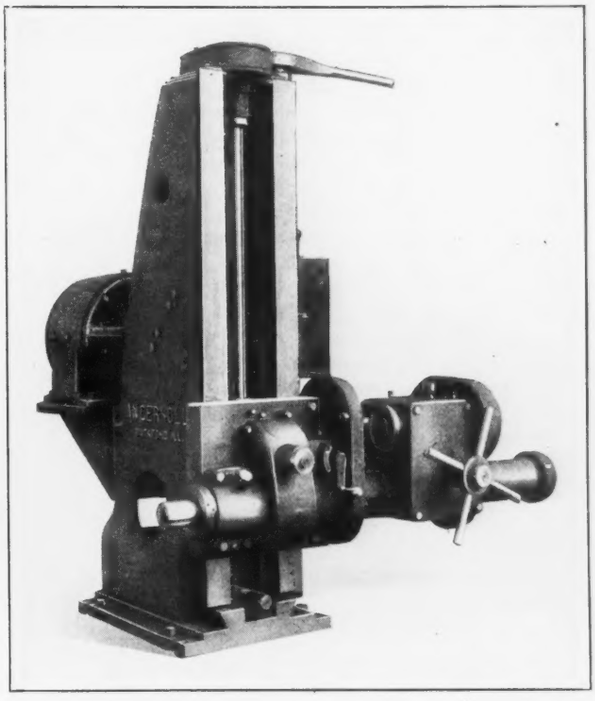


Fig. 9. Portable Boring Machine designed for General Utility about the Shop

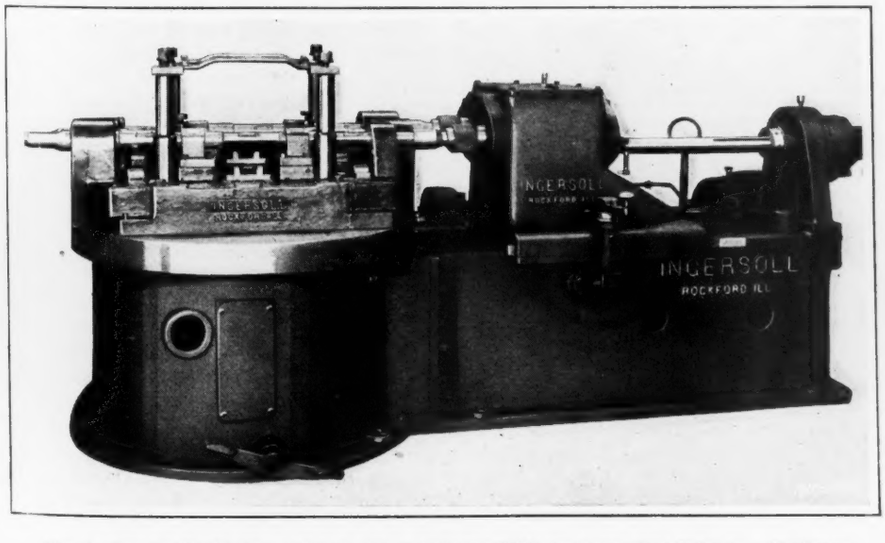


Fig. 8. Two-spindle Machine equipped with an Indexing Table for boring Four Holes in a Crankcase cast Integral with the Cylinder Block

Machines for Boring Crankcases and Transmission Cases

A two-spindle horizontal machine for rough- and finish-boring the three camshaft holes and the starter hole in a crankcase cast integral with a six-cylinder motor block, is illustrated in Fig. 8. This machine is equipped with a two-station indexing table which permits the operator to remove a completed block and replace it with a rough one while the

operation is being performed on a block in the other station. Thus the machine is almost continuous in operation, the only time lost being that required for indexing the table. Any rate of feed or quick traverse is obtainable through the control lever at the right hand of the operator. In this illustration may be seen a dial gage which gives the pressure of the Oilgear feed with which the machine is equipped.

A two-way horizontal boring machine weighing about 44,000 pounds was developed for boring tractor transmission cases. Fig. 4 shows a close-up view of the tooling provided on the two saddles, and Fig. 5, a view taken from the same position with the work in place. From these illustrations can be clearly seen the arrangement of the cutter-blade blocks in the boring-bars. The operator and his helper together load a transmission case in the fixture and locate it from milled surfaces and dowel-pins. With the roughing cutters in all bars, the right-hand saddle is then run up to the work and the feed started. While this step is in process, the left-hand saddle is started to rough- and finish-bore at one pass of the tools, the saddle being allowed to feed up to a positive stop.

When the right-hand saddle reaches a stop at the completion of the roughing cut, it makes a quick return to the starting point, and the roughing cutters are replaced with finishing tools. Then the saddle is moved forward with the rapid traverse to the work and the feed engaged for finish-boring. At the end of the finish-boring, while the saddle is held against the positive stop, the operator releases a spring tension on each spindle, which forces a counterboring tool against the work to a positive stop, for the final finishing cut of about 1/64 inch. This method of finishing counterbored holes eliminates the possibility of springing the castings and gives a very accurate finish.

An independent adjustment and an independent stop is provided for each counterboring head. By the time the counterbores are started, the left-hand saddle tools have finished their cuts, and this saddle can be returned to the starting position. Each saddle is driven by an individual 15-horsepower motor. All feeds and the rapid traverse of the heads in both directions are controlled by two levers, one for each head. The machine is 24 feet long, 7 feet wide, and 5 feet high.

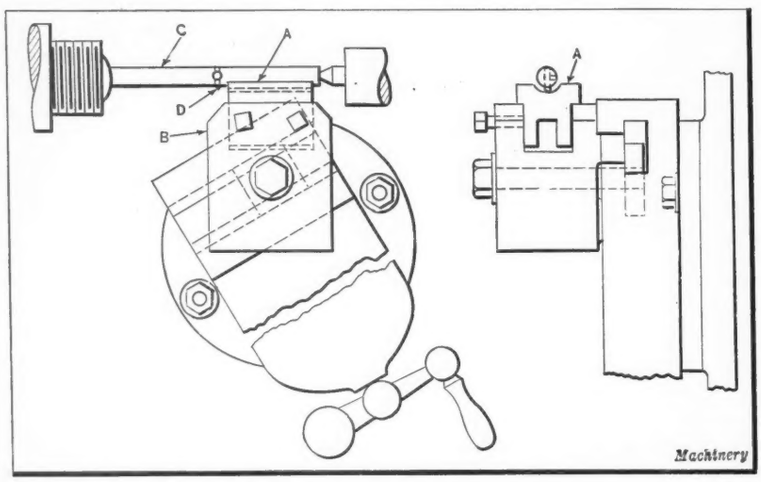


Fig. 2. Diagram showing Method of cutting Half-thread in Tool-block

Another boring machine not intended for use primarily in automobile shops, but which embodies a number of advantageous features, is shown in Fig. 9. This is a portable equipment built for use in the Ingersoll plant. It is only 5 feet high, but is one of the handiest tools around the shop and is always at work. It is taken from job to job by simply picking it up with a crane hooked in a ring at the top of the housing.

Various feeds and speeds of the spindle of this equipment are obtained through pick-off gears and a variable-speed motor mounted on the back of the housing. The extra pick-off gears are kept in the lower part of the housing where they are easily reached through the opening seen in the illustration. Everything used in connection with this tool is carried with it in a fixed place except the boring-bars and drills. These are kept in the tool-crib, as they are also used in radial drilling machines and other boring machines about the shop.

* * *

CUTTING A HALF-THREAD

By HENRY DAUT

One of the most interesting jobs that passed through the writer's hands during the war was the making of an adjustable tool-block for a slotting bar. This tool-block was shaped, as shown in Fig. 1, to fit a slide, and was threaded on the rear side to fit an adjusting screw. In the beginning, these blocks were made in pairs, the first operation being that of drilling and tapping the steel blanks. Then the blanks were placed on a threaded arbor, and both ends faced, after which they were milled to the required shape. In the final operation, the pieces were cut apart and carefully fitted to the slide. This method was rather expensive, and as large quantities were to be made, it was decided to devise a more economical way of machining the blocks.

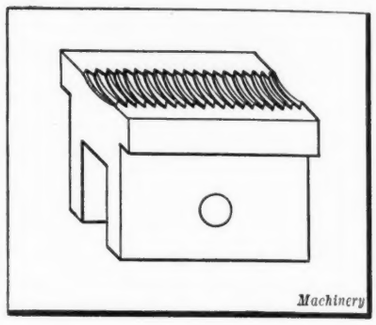


Fig. 1. Tool-block with Half-thread cut in One Side

The method finally used, which proved very satisfactory, is described in the following: The tool-blocks were first planed to shape in strips several feet long, after which they were sawed off to the required length ready for threading. Fig. 2 shows how the threading operation was performed. The tool-block *A*, which is in position for threading, is held in a fixture *B*, secured to the tool-rest of the lathe. This fixture is simply a piece of steel in which an opening is cut to receive the tool-block, and which is provided with two set-screws for clamping the work in the fixture.

The threading tool consists of a small cutter-bar *C*, in which a fly cutter *D* is used to bore the half-hole to the root diameter of the thread. One end of the cutter-bar is held in the chuck, while the other end is supported by the lathe center. After a considerable number of the pieces have been bored to the root diameter, the fly cutter is replaced by a threading cutter, the lathe change-gears set to give the required number of threads per inch, and the thread cut by feeding the work past the revolving cutter.

* * *

An idea of the extent of the machine shop departments at the Ford plant in Detroit may perhaps be gained from the fact that over 10,000 machine tools are moved annually in the shop, due to efforts to improve and facilitate the manufacturing processes, and fifteen men are steadily employed simply for moving equipment into other departments or into other positions that have been found more advantageous for the process of manufacture. Another interesting item is that 30 tons of steel are worked up daily in the Ford fabricating shop for equipment of different kinds used in the various Ford plants.

The Machine Tool Industry in 1925

FIVE YEARS IN THE INDUSTRY

By O. B. ILES, President, National Machine Tool Builders' Association, President, International Machine Tool Corporation, Indianapolis, Ind.

In July, 1920, the demand for machine tools dropped off suddenly, leaving the manufacturers with largely expanded shops, a great amount of equipment, and a very heavy inventory of finished machines and parts in process, as well as raw material. The expansion was due to the demand caused by the war and the pressure of the government for more production.

At the end of the war, the government owned a large quantity of used machine tools which were put in warehouses, and which have since been disposed of to used machine tool dealers, and otherwise. A number of large manufacturing plants were also overstocked with used machine tools. These have also been disposed of in like manner, and during the last four and one-half years there have been a great number of used machines on the market. However, from indications, these are quite well absorbed now, so far as those in good condition are concerned, at least.

The Industry has Passed Through a Severe Depression

The year 1921 showed very heavy losses for most machine tool builders, and the year 1922 was very little better. However, the year 1923 showed considerable improvement, and many of the machine tool builders were able to either break even or get some returns on their investments. Some had losses. The year 1924 was not so good as 1923. It started fairly well, but the demand slackened in the middle of the year, with the result that machine tool builders have not done so well as they did in 1923, except possibly a few builders of highly specialized machines.

During the last four years, most of the members of the National Machine Tool Builders' Association have had time either to completely redesign their line, or improve and strengthen it. The result is that today most of the machine tool builders in the United States have a very different line from that produced before and during the war, embodying many improvements; so much so that the users of machine tools who do not appreciate this and still insist on using old machines, are going to be at a disadvantage in their competition with manufacturers who use the present machines with their higher production capacity. Most of the machine tool builders have been endeavoring to get this fact before the users of machine tools.

Good Business Ahead in the Machine Tool Field

From surveys made, the outlook for 1925 is much better than at any time since the war. The result is that most of the manufacturers are expecting much better business. The surveys show that a number of industries have in mind expanding either with new plants to be equipped with new and modern machine tools, or by replacing old and obsolete machines with new. The machine tool manufacturers are expecting a business at least as good as that in 1923; but from the information I have, they are not expecting a boom and are not planning their program with a boom in mind. Furthermore, the experience which most or all of them had with the loss occasioned by the large inventories in 1920 and 1921, has led them to change their methods and plans in regard to building large amounts of machines for stock.

Their present plan is to carry as small an inventory as possible and to build machines where the prospect for disposing of them is in sight and not otherwise. Should there be a boom or a large demand for machine tools, the users may have trouble in getting deliveries. I find most of the machine tool builders inclined to be conservative and not take the chances for loss attendant upon large stocks and inventories.

The better outlook is also helped by the improved conditions and outlook in Europe at the present time. Some manufacturers are already obtaining inquiries and orders from Europe; but they also have a conservative feeling in regard to the export business. Taking it all in all, it is my impression that the machine tool builders are looking to the future with hope, but are inclined to be conservative.

* * *

NEW TENDENCIES IN THE FIELD

By THEODORE TRECKER
President, Kearney & Trecker Corporation, Milwaukee, Wis.

Two tendencies may be quite definitely discerned among progressive manufacturers in the selection and use of their machine tool equipment. One is a growing realization that it is costly to employ high-priced labor in the operation of inefficient, out-of-date machine tools. The second is a more general appreciation of the fact that a machine can produce its best work only when equipped with suitable jigs, tools, and fixtures; therefore, machine tool builders are being asked, to a greater extent than ever before, to provide not only the machine tool itself, but also the equipment required for increasing the efficiency of the machine to the highest possible degree.

As a result, a new problem confronts the machine tool builder. He has to act in the capacity of a consulting production engineer, as well as a builder of machine tools. The right kind of auxiliary equipment, properly designed and built, may increase the productive capacity of a machine tool several times. However, to produce such equipment, the machine tool builder must develop an engineering service such as he did not need to provide in the past. Practically every problem presented to this consulting engineering service is different from those previously encountered. In some cases the problems may look alike, but such apparently minor details as differences in the materials, quantity to be handled, and type of machine available for doing the work radically change the requirements, and an entirely different type of auxiliary equipment must be designed.

The most difficult feature of this new service provided by the machine tool builder is to obtain a sufficient price to cover all the costs involved. When the customer buys a machine, he buys a product that has been turned out in quantity, so that the engineering work is distributed over a large volume of business and the manufacturing is carried on, to some extent at least, on a quantity basis; but when he buys special tooling equipment for that machine, he buys something that must be specially designed for his use, and a single outfit is built to meet his requirements. The cost of this, of course, is very much greater, pound for pound, than the cost of any standard machine tool. The customers, although themselves engaged in metal-working manufacturing processes, often are unable to understand this, and complain that the equipment prices are too high. As a matter of fact, they are generally entirely too low, and if machine tool builders are to survive in conducting a consulting engineering business of this kind, they must carefully watch their costs and be sure to obtain a sufficiently high price for special equipment. Furthermore, the risks undertaken are much greater, because the reputable manufacturer must make good on each individual job, irrespective of how much it may cost him to experiment and try out the equipment until it works to satisfaction in the customer's shop.

Generally speaking, the prospects for 1925 are good for those who have labor-saving machines and equipment to sell. There will be a tendency to buy more and more tooling equipment so as to obtain greater production per machine. Consequently, the number of machines sold will be proportionately less and competition will be keener. As general business prosperity returns, there will not be so much of a tendency to buy the cheapest equipment available, but rather to obtain the most productive equipment, and the machine tool builders who will get the largest share of the business are those who are able to "deliver the goods."

* * *

THE PROSPECTS AHEAD

By N. W. FOSTER
Vice-President and General Manager, National Acme Co., Cleveland, Ohio

The promise of a good normal business in most of the industries using machine tools in 1925 indicates a fair demand for tools. Most manufacturers using machine shop equipment, however, have sufficient plant to take care of their production and there is no need of expansion, so that the machine tool business during the coming year will be mainly a replacement business—probably 75 per cent will be in that class. The replacement market, however, will steadily increase because of the great number of worn out and obsolete machines still found in most machine shops. It is seldom that the advantages of replacement have been more obvious than at the present time, because it may be said without exaggeration that there have been more improvements made in machine tools in the last three years than at any previous time during a ten-year period. Furthermore, during the last four years, few users of machine tools have taken full advantage of the new improvements, because of the stagnant markets for their own products.

Present indications show a change in the attitude of mind. Many machine tool builders have made more quotations in the last six months than in a year previously. The second-hand market is free from modern tools, and only the old tools that can hardly be sold are left. Furthermore, many appropriations for new equipment have been held up awaiting the outcome of the election. The shop organizations have asked for new equipment, and these requests will now be heeded and many orders for new equipment placed. This is especially true in regard to railroad shop equipment which has been held up for a year.

The foreign market shows an increasing strength, business having recently been booked by machine tool builders from several European countries, including Sweden, Germany, and Austria, which have placed more orders in the last two months than in two years previously.

Many consider that 1923, generally speaking, was a normal year in the machine tool business as far as demand was concerned; and if it did not appear normal to machine tool builders, it was because of the excess plant capacity of the machine tool shops. The 1924 business in automatic machinery was about 60 per cent of that of 1923. During the coming year the automobile industry will be the main buyer of automatic machinery, followed closely by the electrical industry. Approximately two-thirds of the automatic machines built go to the automobile or allied fields, although it is true that an increasing percentage has gone to other industries during the last four years. Among the new fields that will create a demand for machine tools may be mentioned the mechanical refrigeration field and, to some extent, the radio field. The prospects for the rapid industrial development of the Pacific Coast promise a fair amount of machine tool business.

The problem of the greatest importance to machine tool builders is how to reduce the plant capacity of the industry. Wherever plants can be consolidated, it will aid the strength of the industry as a whole, because a real saving will thereby be accomplished. The mere consolidation of businesses, without the consolidation of plants and the reduction of plant capacity, is of minor importance.

MILLING SIDES OF REGULAR POLYGONS

By CHARLES KUGLER

The formulas given in Fig. 2, were worked out for the purpose of eliminating the cut-and-try method of milling regular polygons with an odd number of sides in order to obtain a given height B, or to diminish the height A a definite amount. By the use of these formulas the operator can determine just how much to raise the milling machine table in order to machine the work to the required dimensions. The writer has often seen work of this kind spoiled when the cut-and-try method was used; this would not have happened if the formulas given in the following had been employed.

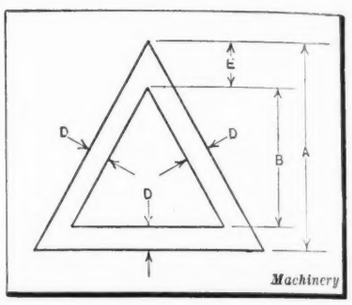


Fig. 1. Diagram used in deriving Formulas for Three-sided Polygon

Referring to Fig. 1, the derivation of the formula for the three-sided polygon is as follows:

Let D = depth of cut;

$D + E$ = decrease in altitude;

$E = D \div \sin 30$ degrees $= D \div 0.5$ or $E = 2D$

Now

$$D + E = 3D \text{ or } D \times 3$$

and

$$B = A - D \times 3$$

from which we have

$$D = \frac{A - B}{3}$$

It will be noted that the formulas given in Fig. 2 apply to regular polygons having an odd number of sides. The derivation of a formula for any regular polygon having an unequal number of sides may be worked out in the same way as for a polygon having three sides.

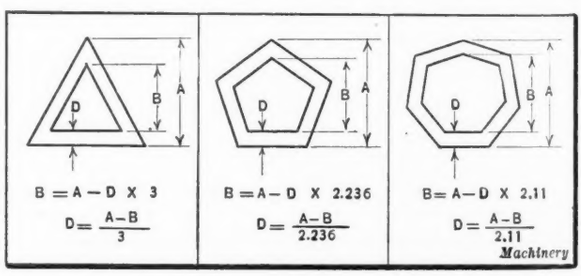


Fig. 2. Formulas for Use in milling Regular Polygons

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NEW COMMERCE YEAR BOOK

The Department of Commerce has just brought out the second annual issue of the Commerce Year Book, covering the conditions of industry and commerce throughout the world. The book is intended to serve as a guide in the study of problems of trade, production, price changes, and market conditions. It contains a summary of the general trend of business throughout the year, together with an outline of the basic factors that influenced trade. Information is given on domestic trade and labor conditions, and material is included on prices, agricultural production, fuel and power (covering the coal, petroleum, and electrical industries), metals (including iron and steel, copper, lead, zinc, aluminum, and tin), building activity, machinery, railway, textile, leather, paper, automotive, rubber, and chemical industries, transportation, finance and banking, foreign trade, and economic developments in the principal foreign countries. The price of this report is 85 cents.

The Gear Industry During the Coming Year

EXPECTED ACTIVITY IN 1925

By GEORGE L. MARKLAND, Jr., Chairman of the Board of Directors of the Philadelphia Gear Works, Philadelphia, Pa., and President of the American Gear Manufacturers' Association

There are two distinct fields in the gear industry which must be dealt with separately—the automotive and the industrial gear fields. During the past year, the automotive gear producing plants had a capacity of about twice the demand, but present indications are that in 1925 these shops will be operated to at least 75 per cent of their capacity. The annual demand for passenger cars will soon reach 4,000,000, and in addition there is a steadily increasing demand for trucks and tractors, while the bus business is still in its infancy. The trolley car on the streets in our large cities will sooner or later have to pass away, and the bus will take its place for both urban and interurban transportation in many instances. This implies a greater demand for gears. The automobile manufacturers are learning that the gear specialist is able to produce better gears at a lower total cost than they can themselves.

The industrial gear business occupied only 50 per cent of the gear manufacturers' capacity during the first six months of 1924. However, it has been steadily improving since last July, and I predict a full capacity demand in the industrial gear business during 1925. This will involve the need for more and better equipment in many gear-cutting plants.

One noticeable feature in the industrial gear field is the increasingly heavy demand for speed-reducing gear units. Herringbone gears are growing in favor, and spiral bevel gears are becoming more generally used.

* * *

THE SERVICE RENDERED BY THE GEAR INDUSTRY

By F. W. SINRAM, President, Van Dorn & Dutton Co., Cleveland, Ohio Honorary President, American Gear Manufacturers' Association

In speaking of the prospects of the gear industry, it is necessary to distinguish between the automotive gear field and the field for industrial gears. Considering first automotive gears, it is evident that this business is directly in proportion to automobile, truck, tractor, and bus production. As it is generally expected that the passenger automobile production in 1925 will be about the same as in 1924, although it is likely to be more evenly distributed over the entire year, and that the truck, tractor, and bus production will be considerably greater, the total volume of business of gear manufacturers in the automotive field during the coming year should be greater than in 1924.

Should Automotive Manufacturers Cut their Own Gears?

As the automotive industry is gradually becoming more and more concentrated in the hands of a comparatively few companies, and the unit plants of these companies are thereby becoming larger, there is an increasing tendency to make many parts that were formerly bought. Along with this tendency comes the temptation to undertake the production of all gears in the automobile and truck builder's own plant. With reference particularly to gears, the wisdom of this procedure may be questioned. Only in a few cases where the production of the automotive manufacturer is so great that he can afford to obtain special machinery that will produce his particular gears considerably cheaper, can economy be obtained in this way. A limited number of automotive manufacturers use a sufficient number of gears to warrant the installation of special departments for this purpose, and it would appear to be a wrong economic policy to add to the gear-producing capacity for automotive gears, which is already ample to take care of the requirements of the entire automotive industry for years to come.

It should also be remembered that it is doubtful if a department for producing gears, installed at the present time, could compete in the matter of cost with the gear specialist. Much of his equipment was installed at lower prices than the same machines can be obtained for now, and it is the writer's opinion that the automotive industry as a whole could further the business in other directions with the money required for the installation of gear departments, to much better advantage. It takes a large fixed investment for producing gears, having in mind the sales value of the product.

The Value of the Experience of the Gear Specialist

Furthermore, the gear specialist is engaged in the production of gears for a number of automotive manufacturers, and a few gear manufacturers in this field operate extensive industrial departments as well, where gears for numerous other applications are produced. The result is a wide and varied experience. The automotive manufacturer who makes his own gears gains experience on those gears only. Many automobile builders underestimate the value of the experience of the gear specialist; and even if they should place a gear specialist with broad experience in charge of a new gear department, he is likely to get into a rut when his experience is limited only to his own gears. In the case of the very large automotive manufacturers, there may be exceptions to this statement, but what has been said is intended to apply to the average plant. There is a tendency toward over-capacity of gear facilities in the automotive field, and it seems wrong economy to add further to this over-capacity.

Many years' experience in the gear field has satisfied the writer that on the whole better gears will go into automobiles, trucks, tractors, and buses if produced by gear specialists. When gears are bought, they are produced according to specifications agreed upon at the time of contract. If the gears do not meet these specifications, the customer does not accept them. When they are made in his own plant, with every desire to maintain a high standard of quality, it is only human that the product will be used, if possible, to save losses, although not exactly correct—in some cases perhaps to the detriment of the car. Judgment may be influenced in the interest of profits. It is also natural that a gear specialist who devotes his entire time to gears—a highly technical product—should be able to produce better results. Of course, all gear manufacturers are not producing the same quality, and the automotive manufacturer must be careful in the selection of his source of supply, but this applies equally to any other line of manufacture.

The Industrial Gear Field

In the industrial gear field there is no over-capacity of gear facilities in normal times. The year 1924 has not kept all the plants busy, because the machine-building industries in general, who buy and use gears, have not been fully occupied. The outlook for 1925 in the general industrial field is good, and will increase the demand for gears to such an extent that probably some plants will find it desirable to add facilities here and there during the year. Increased business will also come to the industrial gear manufacturers because of the fact that more and more concerns that use gears in their product turn to the gear specialist with their gear problems. Many well established concerns who for

years have made their own gears have recently turned their work over to gear specialists. By an active selling campaign, the gear manufacturers can increase this volume of business, because, generally speaking, they can produce better gears at a smaller cost than the small gear department of the ordinary industrial plant.

The gear specialist may be of considerable assistance to the manufacturer in other fields when designing equipment containing gears. The ordinary machine designer—an expert in his own line of equipment—cannot be expected to be an expert on everything, including gears, and therefore it is wholly in order that he should call for the advice and assistance of the gear manufacturer in determining upon the design of gearing. In this way often much better gears at lower cost may be worked into the design than would otherwise be the case.

* * *

LATHE EQUIPPED FOR MILLING IRREGULAR GROOVES

By S. ALMOND

The Hendey lathe shown in Fig. 1 is equipped for milling grooves in the lower half of a forming die used in rolling the edge of a cover for an irregular shaped candy box. In Fig. 2 are shown three leaders or cams used to control the movement of the milling cutter when milling the grooves in three different forming dies. It will be noted that the cam or leader shown at *A*, Figs. 1 and 2, is heart shaped. The die shown in Fig. 3 is used in rolling the edge of a triangular-shaped candy box such as shown at *B*, Fig. 2.

Referring to Fig. 1, the compound rest of the lathe is set parallel with the V-ways, and the casting *C* fastened to the end of the slide in such a position that the follower roll *D* is in contact with the heart-shaped cam *A* which is secured to the faceplate. The special block *E* that supports the groove-milling cutter is clamped to the compound rest, and the cross-slide feed of the lathe is disengaged, the same as for taper turning with a taper attachment. A small pulley *F* is arranged on the bracket at the back of the lathe, over which a strap is hung, one end of which is fastened to a stud on the cross-slide and the other to weights that keep roll *D* in contact with cam *A*.

An electric drill *G* is used to drive the cutter, the motor being placed on a small platform fastened to the cross-slide. A flat board *H* is laid across the V-ways of the lathe, and two rollers, one of which is shown at *J*, are placed between the platform and the board *H* to allow the motor to travel back and forth with the cross-slide in accordance with the movement imparted by cam *A*. The speed of the lathe spindle was reduced to about two revolutions a minute by the use of an additional countershaft and suitable pulleys. At this speed it was found possible to feed the cutter into the work about 0.001 to 0.002 inch per revolution. The work is not shown in place in Fig. 1. It should be mentioned here that the lower part of the die is turned down to fit the large hole bored in cam *A*.

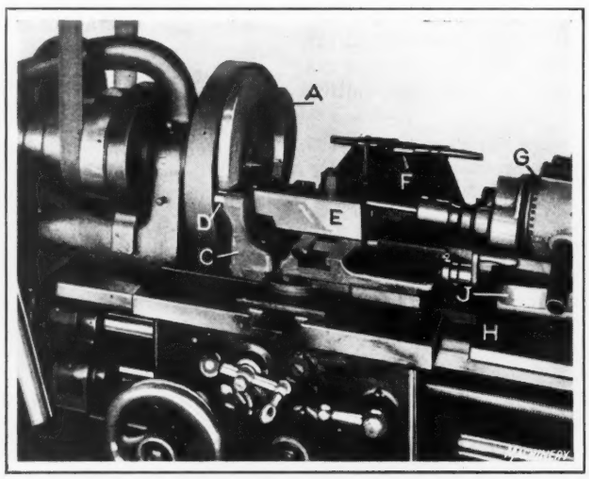

Fig. 1. Lathe equipped for milling Irregular Grooves in Dies

Fig. 2. Leaders or Cams used in milling Irregular Grooves in Dies

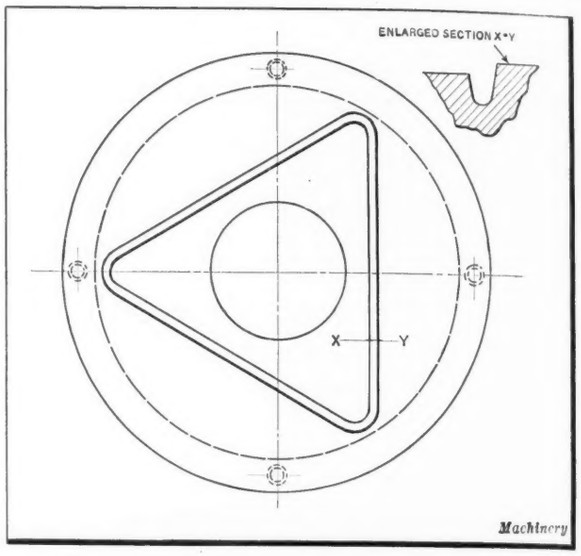

Fig. 3. Die used for rolling the Edge of Candy Box Covers

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Every so often we learn that the secret of hardening copper, lost some two thousand years ago with the passing of the ancient Egyptian civilization, has been rediscovered. One of the latest "rediscoveries" was told by the newspapers as having been made by a railway switchman and as having been bought outright by a large copper company for a sum of money running into seven figures. In the first place, financial and industrial captains are not likely to pay such sums of money outright for any invention—but consider the value of hardening copper. If it could be done successfully, just what value would that process have? Even if copper could be hardened so that it would cut like steel, why should anyone want to use copper to any extent for purposes where steel—a product ever so much cheaper—can be used? To the ancients, a comparatively slight hardening of copper was, of course, of great value, because they did not know of steel or the methods of hardening steel; but many of the things that were valuable to the ancients are of no value today, because we have cheaper and better substitutes for most of the products known to them.

* * *

At the annual meeting of the Society of Industrial Engineers held in Chicago, in November, the following officers were elected: President, W. G. Sheehan; treasurer, Edward T. Miller; executive secretary, George C. Dent; vice-president in charge of research, Professor Charles B. Gordy; vice-president in charge of promotion, Eugene A. Rummler; vice-president in charge of education, Professor Walter F. Rittman.

GROUP AND GANG MILLING FOR ECONOMICAL PRODUCTION

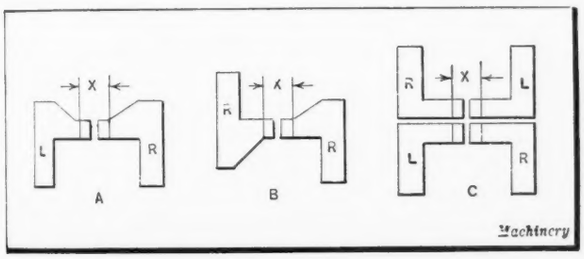
By ERNEST L. HOLCOMB

In modern manufacturing, it is the accepted practice to have one operator run as many machines as he can handle economically, the economy depending upon a proper balance between the operator's time and the machine time, so that neither the operator nor the machines will be unduly idle. This practice is common with many kinds of machines, and as they must be either automatic or semi-automatic, the tendency is to use automatic machinery whenever the production is large enough to pay for the installation within a reasonable period.

Conditions Favorable to Group and Gang Milling

In this article will be outlined some of the conditions under which group and gang power milling are desirable. These conditions are as follows:

1. When different surfaces are to be milled on the same part, and the cuts are of approximately the same length and long enough to give the operator time to change and gage parts on one machine while another machine is cutting, group milling is advantageous. In fact, the grouping of machines is practically an economic necessity in this case, and gang milling is also desirable. Often gang milling and the group method may be used together by clamping several parts in each fixture to allow a cut of sufficient duration. It is most satisfactory to pass the parts directly from



Several Ways in which Right- and Left-hand Parts may be clamped for gang-milling

one machine to the other, but sometimes the second cut must be taken after intervening operations to obtain the advantage of group milling. This requires more careful scheduling than if the parts pass directly from one machine to another. All cuts taken by one operator should be charged to the same operation number if possible, so that the operator will not need to divide his time. This method will also save orders and records.

2. Milling may be done with two or more duplicate set-ups on the same part, if the production warrants the tool and set-up expense. This method is desirable when no other cut of equal length (on the same part) can be arranged. One operation number is used in this case, because the same cut is taken on each machine.

3. Two or more different parts may be milled on separate machines tended by one operator, when the cutting time is long enough to give the operator time to change the parts. These may be large single pieces or smaller pieces clamped in a vise or on an arbor, it being possible to arrange an endless variety of combinations. The principal disadvantage of running different parts together is the difficulty of always maintaining a supply on hand, and for this reason, the second method is preferable. When using the third method, the operator's time must be divided, because the different parts will have separate part and operation numbers.

4. When there is a long milling cut taken by one machine and no other milling operation to match the first, and when production requirements do not justify duplicate tool and machine equipment, a burr-filing, drilling, or other machine operation may be performed to permit a group of machines to be used.

5. Right- and left-hand parts may be milled at one setting, with an operator running one machine if the cut is short, or two machines if the cut is long enough. This method is intended to keep the stock of right- and left-hand parts balanced, but in actual practice the stock becomes out of balance, because the number of rejections, broken or spoiled parts, and the number called for on part orders, etc., will not be the same for both parts. This makes it necessary from time to time to run single lots of right- or left-hand parts to balance the finished stock. In milling operations, this method is likely to cost twice the regular piece rate, and on other work it is at least inconvenient.

Alternate Methods of Milling Right- and Left-hand Parts

If instead of milling both right- and left-hand parts at one setting, as shown at *A* in the illustration, the fixture is made so that two pieces of either type may be clamped as indicated at *B*, it will be easy to keep finished stock balanced by issuing production orders to suit requirements. Also, in this way less time will be lost in waiting for castings, blanks, etc., as the parts that happen to be ready can be machined without loss of production or extra cost. If the cut is long enough, under normal conditions an operator would run right-hand parts on one machine and left-hand parts on another. In this illustration, *X* indicates the width of the milling cut.

When the parts are of such shape that they can be clamped as shown at *C*, it is probably best to mill them in sets for the sake of increased production, even if the two types do get out of balance occasionally. The parts may be rearranged at *A*, *B*, and *C*, so that the surfaces to be milled will be in line, allowing the use of a narrower cutter and making the cut longer.

Not all factories can run sufficiently large quantities to obtain the advantages possible with group or gang milling. However, a small or medium-sized factory can often simplify the problem by reducing the number of varieties or models manufactured. Concentration of production on the fewest parts, if sales are not affected unfavorably, is the surest way to lower production costs.

* * *

TAXES IN GERMANY

R. E. Schoenfeld, American Consul in Berlin, in a report made to the Department of Commerce covering taxation in Germany, states that the direct tax on German commercial, industrial, and agrarian enterprises now amounts to an average of 50 per cent of their net income. He says, moreover, that if this estimate is at all in error, the error is on the side of conservatism rather than on the side of exaggeration. Assuming this statement to be correct, the general conception that Germany's tax burden is relatively light must be revised. Seymour Parker Gilbert, agent general in charge of reparation payments, announces that Germany's reparation payments in goods in kind during September and October totaled 170,000,000 gold marks, and that the cash payments amounted to 70,000,000 gold marks. Owen D. Young, who assisted in framing the Dawes plan and who had charge of putting it in operation, states that the reparation requirements for the present fiscal year beginning September 1,—1,000,000,000 gold marks—are practically in hand.

* * *

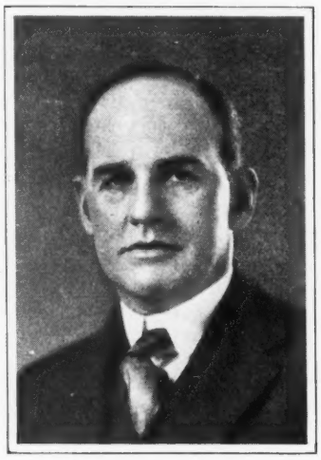
The office executives division of the American Management Association held a conference in New York City, December 11 and 12. Papers were read entitled "Principles of Salary Administration," "Salary Standardization," "A Method and Device for Wage Control," "Grading the Office Job," and "Statistical Studies of Salary Data." Other papers dealt with training of office employes, clerical workers, and filing clerks. A paper was also read on standardization of office equipment and on measurement and control of office output. The office of the American Management Association is at 20 Vesey St., New York City.

The Future of the Automobile Industry

TENDENCIES IN THE AUTOMOBILE FIELD

By ALVAN MACAULEY
President, Packard Motor Car Co., Detroit, Mich.

For the last fifteen years the tendency in the automobile industry has been toward the concentration of business in a constantly decreasing number of stronger and bigger producing companies. It will probably surprise many manufacturers and engineers in the mechanical industries, who are not directly engaged in the automotive field, to learn that in 1910 there were 230 manufacturers of passenger automobiles, while in 1920 this number was reduced to 152, and in 1924, to 89. It is perhaps even more significant that of the companies remaining in the business, the ten largest producers make 89 per cent of the number of cars built, while the remaining 79 manufacturers make only 11 per cent. The present tendency is toward still further concentration of the business in the hands of the automobile producers who are in the strongest position, and a further expansion of their business may be expected. It would not be surprising if practically all the passenger automobile business five years hence would be found to be concentrated in the hands of about a dozen makers.



Alvan Macauley

The automobile manufacturers whose products enjoy a good reputation and who, therefore, can look forward to obtaining their full share of the potential business during the coming year find that the indications pointing toward a satisfactory business are very favorable. There are now nearly sixteen million cars and trucks in use in the United States, and as the average life of an automobile is approximately seven years, the replacement business alone will amount to nearly 2,300,000 cars. This, in addition to new demand constantly being created by the more universal use of automobiles, would make it safe to predict that the production in 1925, while it may not reach the peak of 1923, will at least equal the production of 1924; and the production of the first six months of the coming year may be expected to exceed that of the first six months of 1924. The export trade is also constantly increasing and while, compared with the domestic trade, it has never been very large in volume, it has gradually developed until it accounts for over 200,000 cars a year.

Plant Extension and Increase of Manufacturing Facilities

In regard to plant extension and the development of the manufacturing facilities of the companies in whose hands the business will more and more concentrate, it is safe to say that these manufacturers will engage increasingly in the making of their own materials, such as glass, woodwork, and upholstery, or at least gain control of sufficient sources of supply of these materials. They will also be likely to engage more and more in the manufacture of all the parts and accessories that enter into an automobile; and to the extent that automobile builders engage in these lines of manufacture, new equipment and shop facilities will be required.

Replacement of old equipment will also take place whenever new equipment of a standard or specialized nature will show a definite saving in the ultimate manufacturing cost. The keenness of competition at the present time requires that manufacturing costs be reduced to the lowest possible level, and the progressive automobile manufacturers will install new machinery even when the saving may be quite small, as it often is, because of the already greatly reduced labor costs in comparison with overhead and selling costs.

In this new equipment there will be a strong tendency toward the use of electric drive and control. Not only will motor-driven machines be in constantly greater demand, but in specialized automatic machines, auxiliary motors are likely to be used to provide for the various automatic movements of the machine. Electric welding processes and electrical appliances of all kinds are also likely to be more and more adapted for use in automobile manufacturing plants.

The Selling Cost of Automobiles

It is often remarked that the selling cost of automobiles is unduly high in proportion to the manufacturing cost. No doubt it is quite high, but much as the automobile manufacturer would like to do so, it is not within his power to reduce it. The buyer still insists upon being sold. In the selection of his car he wants to be urged, and instead of going to the trouble, himself, of studying the features of different cars, he expects a salesman representing each make to act as his individual instructor. In other words, he expects the buying of an automobile to be made just as simple and easy for him as possible, and this makes it necessary for the seller to assume costs that would not otherwise be necessary.

It should also be pointed out that the percentage of selling costs in the marketing of automobiles is not so high as it is in the selling of a great many other specialty lines of manufacture, as, for example, adding machines, cash registers, sewing machines, typewriters, phonographs, and pianos. In some of these lines, the selling cost is so much greater than the direct manufacturing cost that the expense incident to marketing automobiles seems small by comparison.

The Automobile and the Railroads

There is a point relating to national economy that might well be emphasized in any review relating to the prospects of the automobile industry—that is, the effect of the automobile on the railroads. It has frequently been pointed out that the automobile and the motor bus take a great deal of passenger business away from the railroads, and also that the motor truck makes serious inroads upon the railroad freight business. As far as the reduction in passenger business is concerned, there is no question about the truth of the statement, because the automobile and motor bus provide a more convenient means of short-distance transportation. The same is true of the motor truck for short-haul freight, but whether the latter causes any serious loss to the railroads may be questioned, because it has often been stated that the railroads do not find the short-haul freight business profitable. It is the long-haul freight that pays, and here we have to note the curious fact that the automobile industry is providing the railroads with one of its most profitable sources of freight revenue. Statistics indicate that automobiles and automobile accessories are carried at the highest freight rate, and that the total volume of income from this source exceeds even the income from the carrying of wheat, which in years past was considered the backbone of the railroad freight business.

Hence, what the railroads have lost in one direction they have more than recuperated in another, and the automobile is developing railroad business rather than reducing it.

In another direction, also, the automobile tends to improve, not only the railroad business, but all other businesses that cater to human wants. The automobile raises the standard of living. Some automobile owners may temporarily have to get along with less in other directions until they have adjusted themselves to the new mode of living that a car requires, but gradually the tendency will be to educate them to wanting more things and to exert themselves so that they may be able to obtain those things. No other single development has had such an influence upon increasing the demand for a higher standard of living among our entire population, as the automobile.

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THE DEVELOPMENT OF THE INDUSTRY

By EDWARD S. JORDAN
President, Jordan Motor Car Co., Cleveland, Ohio

To gain a clear understanding of the present conditions in the automobile industry, it is well to review the development of this industry since its inception. Briefly, it has passed through three stages—the engineering, the production, and the merchandising stage—and is now just beginning to enter upon a fourth stage which may be termed the "service" or "normal industrial" stage.

Edward S. Jordan

In the engineering stage, each engineer sought to design a rather unusual vehicle embodying every new idea that he could think of. In the early days of the automobile, therefore, many companies failed because they were not satisfied to market automobiles with features that had been already tried and developed. New models were brought out every year, and sometimes twice a year, and the engineer was paramount in the development. Ford was the first manufacturer to produce a standard car at low cost built exclusively to serve the buyer. Many other manufacturers at that time built cars with features to suit themselves rather than their customers, and in those days so long as a car would run it was considered a success from the designing point of view.

Next came the production stage. The Ford system of assembly was gradually adopted by other manufacturers, and a certain amount of standardization was accepted as necessary to obtain volume in production. The production man domineered the situation, and the main issue became an effort for the increased production of fairly well standardized models.

The third or merchandising stage is the one in which we now find ourselves. Production increased so rapidly that the distributing channels were severely taxed. The major engineering problems had been solved, except that new features were required in new models in order to reduce the value of second-hand cars. The main problem was to sell all that the production system could produce. How severely this requirement taxed the distributing means may be best understood from the fact that from July, 1922, to July, 1923, out of a total of 28,000 dealers at the beginning of that period, the names of 16,000 disappeared from the lists, partly to be succeeded, of course, by other dealers willing to try their hand at the business. The dealer's greatest problem has been that he has had to take old cars in exchange for new. In other words, instead of selling automobiles, he trades, and unless he is properly financed he cannot successfully continue in business for a very long period.

We are now on the threshold of the fourth stage—the service or normal industrial stage—with the industry settling down to a normal business. This is the stage in which the main consideration must be the interest of the buyer. The cost per ton mile of transportation must be reduced to a minimum, commensurate with the kind of transportation offered. To do this, the overhead costs of the automobile industry must be reduced along with the selling costs, and the survival of those engaged in the industry will depend upon their ability to finance their enterprise from the time the raw material arrives in the factory until the last payment has been made by the buyer. In this stage useless models will be eliminated; many companies are now producing entirely too many models. The Ford method of concentration on a single model will become the customary method; the overhead will be reduced by the elimination of bonuses and excessive salaries in executive positions; the cost of distribution will be reduced by financing corporations, which will cut down the dealer's distribution cost; the permanent exhibits of automobiles along the best business streets of every city will be partially, at least, discontinued, thereby reducing the "high-rent cost of distribution."

The standardization of cars will create a tendency to use cars for several years. This, in turn, will reduce production costs by eliminating yearly models and the accompanying requirements for new tool equipment, jigs, and fixtures, which in the past has often upset the whole manufacturing organization. This reduction of the ultimate cost to the purchaser will increase the number of possible sales and reduce the depreciation of cars, which is a true service to the buyer.

As to the prospects for the immediate future, it may be said that the saturation point for low-priced cars has not yet been reached, and the prospective business in buses is very great. The demand for the higher-priced cars will largely come from buyers who formerly have used cheaper cars, as each time they buy a new car they are likely to take a step upward in their requirements; hence a steady volume of business is assured in every type of car that can meet the requirements of a given class of buyers. The year 1925 should be satisfactory to most automobile manufacturers because the dealers have not stocked up this fall, and this, in turn, will prevent over-production this winter. As a result, a more even business may be expected during the entire year.

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THE OUTLOOK FOR THE COMING YEAR

By ALFRED P. SLOAN, Jr.
President, General Motors Corporation, Detroit, Mich.

The automotive industry should enter 1925 with the greatest confidence. Prosperity of the farmer and the wage earner add greatly to the prosperity of the industry. Conditions, both economic and psychological, are such that the purchasing power of both should equal or be greater than it was in 1924. This insures a good volume of business. As is generally known, 1923 was the largest year in our history. This year sales to consumers have been slightly less than last year. I see no reason why 1925 should not equal 1923.

As to General Motors, we enter the new year with our dealers' stocks at a normal level in relation to current consumers' demand. We have sacrificed profits in 1924 to effect this purpose, but we believe it was sound business. The carrying of unreasonable stocks is an economic loss.

We hear a great deal about the stability of the automotive industry. I think progress has been made in that direction during the year just closing. General Motors recognizes that the tremendous increases in production which the industry has enjoyed during its development stage are certainly not going to continue at anywhere near the same rate. The problem now is to eliminate all possible waste.

Foreign Trade Prospects

Opinions of Leading Foreign Machine Tool Dealers

IMPROVED political and financial conditions abroad have led many American machine tool manufacturers and builders of industrial machinery in general to look forward to a material increase in foreign trade during 1925. With a view to ascertaining definitely the general industrial conditions abroad and the prospects for an increased foreign market, MACHINERY has obtained the opinions of a great number of leading machine tool dealers abroad. The information thus obtained is not so encouraging as one might have been led to believe. When one carefully and conscientiously digs down below the surface of the European conditions, one finds that the effects of the war have so completely changed the industrial and financial situation from what it was before the war, that it will take several years of gradual improvement to re-establish business and industry on what might be called a normal basis.

Nevertheless, there is greater hope for improved trade relations with Europe at this time than at any time since the war. The acceptance of the Dawes report by the governments concerned, the more stable exchange, and the more satisfactory political situation, together with a new spirit of willingness to cooperate with the United States, will materially help in bringing about a resumption of more active trade relations in the machinery field. The opinions of the foreign dealers who have contributed to this review are largely quoted verbatim so as to give the American manufacturer a first-hand idea of the prevailing opinions abroad.

Causes of Depreciated Currency

In the countries with depreciated currency, especially in France and Belgium, there seems to be a widespread belief that American business men and financiers are responsible for the low value of the foreign currency, as compared with the dollar. As a matter of fact, it is the financial policies of these nations that have caused their currency to depreciate, and those European countries that have rigorously pursued the policy of a sound currency have a pre-war par value of exchange with the dollar. This matter is beyond the control of American financiers or business men, and the remedy is entirely in the hands of the foreign governments—balanced budgets and the return to a gold standard being the prime requisites.

The adoption of the Dawes plan and the more satisfactory political situation in Europe have led many American manufacturers to believe that the coming year will offer an active market for American machine tools in Europe. Doubtless there will be greatly improved trade relations, but when one carefully and conscientiously digs down below the surface of the European conditions, one finds that the effects of the war have so completely changed the industrial and financial situation, as compared with what it was before the war, that it will take several years of gradual improvement to re-establish business and industry on what might be called a really normal basis.

The Prospects in the British Market

From a machine tool dealer in London we learn that "the ordinary types of American machine tools such as lathes, drilling machines, etc., have no possible chance of being bought in increasing quantities in the British market unless American manufacturers are able to reduce their prices materially, because British as well as German machines of good quality are now produced at much lower prices than those quoted for American machines in Great Britain. There is a limited demand for certain types of more specialized machines, such as high-grade grinding machines, bolt-threading machines, and automatic screw machines; but there will be no great increase in the volume of British imports until the European situation has materially improved."

While the exchange situation in England is gradually improving, there is still a slight discrepancy to the disadvantage of the sales of American machine tools. The amount of unemployment in Great Britain (over one million people being out of work) is sufficient indication of an industrial situation that does not give immediate hope for a great increase in the volume of business in shop equipment.

In regard to prices, the same dealer states: "A short time ago we offered a first-class American grinding machine at £270. A practically identical machine of British make was sold for £200. German machines are also still imported into Great Britain at prices far below those of American machines."

It is generally stated that the quality of these German machines is quite good. Nevertheless, with improved industrial conditions there will always be a fair market for American machine tools in Great Britain, and the American manufacturer is advised "(1) to keep in the market even though it may not be profitable at the present time, and (2) to make special prices for export until Europe has been reconstructed."

The Import Situation in France

Fenwick Freres & Co., of Paris, say: "The exchange rate is the main obstacle to the importation of American machinery into France. Standard machines of the more simple types can no longer be imported to any appreciable extent, because French makers have had a chance to enter this field and are selling machines at about one-half the price of corresponding American tools. Only more specialized machinery of advanced design still finds a market, but even this market is restricted by the high price when expressed in francs; and many factories are keeping their plants running on two shifts to obtain their production, rather than to purchase under present conditions.

"We realize that American manufacturers cannot reduce their selling price in dollars, and hence are unable to offset the handicap of the depreciated exchange. But we would advise them to do something which most of them are in a position to do, and that is to send goods on consignment for payment after sales. This enables the French representative to keep some machines on his floor, sometimes under belt, for demonstration purposes, and ready for instant delivery. The manufacturers who have acted on this suggestion generally have found it to their advantage, because it has been possible to push their line of machines actively, and in that way they received orders which they would never have been able to get in the ordinary course of business.

"American machine tool manufacturers should also remember that even if the European market is practically closed at present, conditions may change so that the cooperation of an active and faithful representative may become very valuable; and therefore, even under the existing conditions, they should continue to lend their representatives all the assistance possible, keeping them supplied with catalogues and price lists, and giving them full information as regards the uses of their machines and output obtained in the United States. It takes quite a while to introduce a line in the market, and this period might be taken advantage of in getting prospective foreign buyers acquainted with new developments in American machine tools."

In France, Belgium, and Italy, the exchange situation offers an almost insurmountable obstacle to a greatly increased market for American machine tools. There seems to be a widespread belief in these countries that American business men and financiers are responsible for the low value of the foreign currency, as compared with the dollar, and many manufacturers abroad do not seem to realize that the matter of exchange is beyond the control of American business men, the remedy being entirely in the hands of their own governments—balanced budgets and the return to a gold standard being the prime requirements.

The Stock of Second-hand Machinery in France

Information obtained from other French machine tool dealers bears out the statements quoted above, one dealer summarizing his opinions as follows: "As it is doubtful whether there will be any decided improvement in the exchange conditions in 1925, we do not believe that any increase in American machinery imports can reasonably be expected during the coming year. At the present rate, French manufacturers cannot justify an investment in new American machine tools, and therefore must be satisfied with the best continental makes or with second-hand American machines. There is a large stock of these tools in excellent condition, which enables manufacturers to replace, on advantageous terms, worn and obsolete machines. These second-hand machines are surplus war machine tools—the entire equipment of factories that have either gone out of business on account of financial difficulties or that have changed over to manufacture some other line. These stocks of second-hand machines will continue to affect the demand for American machine tools during 1925. As an example may be mentioned the case of one of the largest automobile factories, which has a special shop for overhauling used machinery. This firm is said to have bought lately second-hand machine tools for three million francs and expects to purchase more in the future."

Exchange Rate Prevents Sale of American Machines

In the opinion of one dealer: "American machine tool imports into France will not be resumed on a large scale until the rate of exchange falls to from 10 to 12 francs to one dollar. Some American manufacturers still seem to believe that first-class machine tools can be sold at whatever price asked, but when the price is converted into francs the excess cost is too great." The machine tools most likely to sell in the French market, present conditions remaining unchanged, are turret lathes, automatic screw machines, cold-saw cutting-off machines, gear-cutting machines, and precision tool-room lathes.

Another French dealer is somewhat less pessimistic, pointing out that the industrial conditions are somewhat improved and that industry in general is more fully occupied. But he does not anticipate any appreciable increase in the demand for American machinery, as domestic manufacturers are now building more complete lines and the needs of French buyers are better served by home manufacturers each year. In addition to the depreciated franc, this dealer also points to the high French tariff as an obstacle to the importation of foreign machine tools. He says further: There is also a distinct undercurrent of hostile feeling among French buyers who believe that America is largely responsible for the depreciation of their currency."

Another of the oldest and most thoroughly established French dealers points out that the virtual freedom from American competition since the war in the French machine tool market has developed a French machine tool industry which is capable of taking care of the regular standard lines of machines; but even so, the French buyer will be interested in the American product, "provided the price is not more than 40 per cent above the competing domestic product."

During recent months German competition has been of comparatively small importance, because German prices have been excessively high, but this condition is likely to change again with a new commercial treaty with Germany, which will doubtless go into effect early next year. This dealer points out that the conditions in the French market are considerably improved, as compared with previous years, because the great number of machines for sale at low prices that glutted the French market immediately after the war are now to a large extent absorbed.

Prospects for Machine Tool Business in Belgium

The prospects for machine tool sales in Belgium do not differ appreciably from those in France, because much the same conditions obtain in both countries, except that the general industrial situation in Belgium appears to be much better. Henri Benedictus & Co. of Brussels states that business in Belgium was quite satisfactory during 1924. This firm sold a fair number of machines, but they were mostly of Belgian and French manufacture, and a few of German origin. A limited number of machines made in the United States and a few from England were also sold. The obstacle to the sale of American machine tools is the prohibitive price when expressed in francs. Belgian manufacturers

prefer to buy high-grade American machines but are unable to do so, as they must reduce their expenses to compete in the world's markets. While Belgium does not make any of the high-grade machines built in the United States, the domestic manufacturers produce good lathes, milling machines, and boring mills, as well as punching and shearing machines. Several concerns have purchased second-hand American machine tools, and a number of such machines have been imported from the United States and from France.

In regard to the prospects for 1925, it is stated that the outlook for the importation of American machine tools is not promising for the coming year. "Lathes, shapers, drilling machines and planers, as made in Belgium or imported from France, are sold at much cheaper prices than American machines; they are quite satisfactory for present requirements, and will fill temporary needs. However, it is different with specialized machinery. Notwithstanding the high prices, a certain number of high-class milling machines, gear-cutting machines, tool-room lathes, vertical shapers, and cylindrical, surface, and internal grinding machines will be imported—in what quantities will depend upon the developments during the year."

The Serious Influence of Inflation of Values

An increased market in Belgium can be expected only when the exchange has returned to a more normal level, but even such a return will at first bring about a serious industrial crisis, because all prices are now greatly inflated. If the exchange were to come back quickly to more normal figures, it would be difficult to readjust prices and bring down wages in proportion. As a consequence, the Belgian export trade, which is of prime necessity for its industry, would immediately drop off, and thousands of people would be out of work; hence, only a slow and gradual return of the exchange to a more normal basis will remedy the situation, and this, in turn, means that for a long time to come American manufacturers will be seriously handicapped in selling machinery in Belgium.

One of the leading machine tool builders in France advises American manufacturers to send machinery and equipment on consignment to reputable dealers for payment after sales. This would enable the representative abroad to keep the machines on his floor, sometimes under belt for demonstration purposes, ready for instant delivery. Manufacturers who have acted on this suggestion have found it to their advantage, because it has been possible to push their line of machines actively, and they have booked orders they would never have obtained if they had followed the ordinary course instead of adopting this plan.

Isbecque, Todd & Co., also writing from Brussels, expresses practically the same opinions as those quoted above. "As far as we can see, the prospects for 1925 are very little, if any, better than for 1923 and 1924. Owing to the high prices of American machinery, competition is springing up all over the continent, which would not have been the case if the imports of American machine tools had continued at the same rate as before the war. Highly developed types of machine tools have not, however, been attempted by continental manufacturers to any appreciable extent, but if the present situation continues, we should not be surprised to see all classes of American machine tools manufactured in Europe.

A Small Tool Industry is Being Developed in France

"The small tool trade is also very much handicapped, as there are quite a number of French plants producing small tools equal in quality to the American product, and at a lower price as expressed in francs. Nevertheless, we believe that sometime the exchange conditions will right themselves, and would suggest that American manufacturers wait patiently until our problems have been definitely solved, and keep in constant touch with their representatives.

"Apart from machine tools, there is a good business in Belgium for American contractors' equipment, as there is a gret deal of building and excavating going on."

Le Vulcain Belge, of Brussels, emphasizes that the only factor that prevents the selling of American machine tools in Belgium is the rate of exchange. Even with this handicap, there will be some demand for the lately developed and special types of machines not manufactured in Belgium or Europe generally. Special machines for locomotive shops, and, outside of the machine tool field, heavy-duty machines for woodworking are likely to be in demand.

Ateliers Demoor, of Brussels, corroborates the information given by other Belgian dealers, pointing out that vertical turret lathes, automatic machinery, and grinding machines must be bought either from America or from Germany, the German machines being largely copies of American models. As these German machines are considerably cheaper in the Belgian market than the American tools, it is feared that the market for American machines will be very limited, especially as the new developments in the political field will place Germany in a more favorable position than she formerly occupied.

The Outlook in Switzerland

In Switzerland, the handicap of a depreciated currency is not present, but the Swiss industries have passed through a severe crisis since the war. The competition with Germany has been exceedingly keen, both in domestic and export business, and many of the plants in Switzerland ran for years at only about 25 per cent of normal capacity. In fact, some of the plants were forced to close entirely.

According to a statement obtained from L. Kellenberger & Co., of Geneva, the prospects in the industrial situation have improved since the beginning of 1924, and the machine industries are now running about normal; but there is still a financial stringency, and many Swiss manufacturers feel that they cannot afford to pay the high prices of American machines, increased as they are by high freight charges and custom dues. Many German machines have been imported. Several dealers in Switzerland who insisted upon selling only American machines immediately after the war ordered large stocks of such machines but all of these firms have gone into liquidation because they could not compete with the German product. At present there is not a single dealer that handles American machine tools exclusively. Nevertheless, Swiss manufacturers would give preference to American machine tools, could they be obtained at approximately the same prices as other machines.

Another influence that sometimes hampers the sale of American machines is "the objection of some Swiss manufacturers to the high American tariff which places an import duty of 30 per cent on machines of Swiss manufacture, so that special machinery of Swiss origin is practically excluded from the United States, even when competing machines are not manufactured in that country. Manufacturers who suffer from this are giving preference to machines manufactured in countries having a reciprocating tariff policy."

A Summary of the Swiss Situation

Summarizing, Kellenberger & Co. make the following statement: "We do not expect a considerable increase in the import of American machines to Switzerland as long as it is the policy of the United States to hamper the importation of Swiss machinery—that is, as long as the present tariff policy is maintained. If a reciprocating trade policy could be arranged, we believe that high-class machine tools, such as turret lathes, grinding machines, milling machines, gear-cutting machines, broaching machines, and special machines in general could be sold. Standard machine tools such as lathes, drilling machines, and planers can always be bought cheaper from European manufacturers.

"If the American manufacturer is to obtain a greater share of the import business in Switzerland it will be necessary to sell American machines at reduced prices, and there must be a reduction in the shipping rates. Swiss manufacturers would give preference to American machines if they could be bought at a price not more than 20 per cent higher than the products of other countries."

Another Swiss machinery dealer states that the prospects for 1925 are certainly better than for 1923 and 1924, although this does not mean a considerable increase in the trade with America. The favorable factors are specified as follows: The industrial depression appears to have passed, and the electrical, watch, and textile machinery industries are fairly busy. German competition has diminished and the great discrepancy in prices has disappeared; still, German machines are sold at from 30 to 50 per cent below American machines in the case of the better class of machine tools. Some time ago this discrepancy was from 100 to 200 per cent. The dollar and the Swiss franc are practically at par.

Machinery Mostly in Demand in Switzerland

Among the types of machine tools that are likely to be in demand may be mentioned automatic screw machines, universal grinding machines, universal tool grinders, and surface grinders. American small tools, especially measuring tools, are also highly thought of in Switzerland. Where new automatic machines cannot be bought on account of the price, second-hand American automatics and German copies of American makes are now being sold.

In the general field of industrial machinery there is an increased demand for molding machines, as both large and small foundries have been taught to understand the advantages of this type of equipment. Among other American products that will find a ready market during the coming year are agricultural machinery, automobiles, typewriters, cash registers, and accounting machines, radio apparatus, and special machinery for the watch industry. It is probable that American builders of special machinery could obtain quite a business if they made a study of the needs of the Swiss watch industry.

The Swiss market at best is not a large market, but generally the Swiss industry has appreciated high-grade machinery, and as it recovers from the depression, it is likely that it will return to the buying of American products if the American manufacturer can keep in close touch with market conditions.

Machine Tool Trade Prospects in Holland

Dutch machine tool dealers do not sound a very optimistic note. Esmeijer & Co., of Rotterdam, state that there is practically no demand for machine tools in Holland at the present time. A great number of shipyards are without orders, and the repair docks are less well employed than ordinarily. Hence a great deal of machine tool equipment in the shipyards is idle. Another important industry is that of building sugar machinery, but as the sugar business in the Dutch East Indies has passed through a depression, this branch of the industry has also suffered. There are indications, however, that conditions in this field will improve in 1925; but the shipyards will not see a greatly improved business until Germany and Austria are able to import through the harbors of Rotterdam and Amsterdam.

Furthermore, most European factories are over-expanded and have suffered from over-production, keen competition, and low prices, so that they are not in a position to install new machinery. The only field, therefore, for American machine tools is for special machines for high production and there is always a limited demand for automatic machinery, turret lathes, and highly developed milling machines. As regards standard types of machine tools—engine lathes, shapers, plain milling machines, and drilling machines, American prices are too high at present for Dutch conditions. There is a big stock of American and European machine tools, and the prices of available American machinery already in Europe are lower than those quoted by American makers F.O.B. docks, New York. Some new American machine tools have been sold in Holland at prices 50 per cent below those now prevailing in America, simply because dealers wanted to reduce their big stocks.

Strength of European Competition

Moreover, the quality of European made machine tools has improved greatly since the war. Shops that used to build all kinds of machine tools are now specializing on one or two different types—improving quality and reducing costs thereby. Even those Europeans who have been great admirers of American machine tools had to admit that really high-class machine tools were found at the Leipsic Fair last spring and at the Olympia Machine Tool Show in London this fall. The selling of American machine tools in Holland, therefore, will be a matter of price, and this makes the problem all the more difficult. Generally speaking, the high reputation of the American machine tools will make it possible to sell them in the Dutch market provided the difference in price between American and first-class German machines is not more than 25 to 30 per cent; but even so, sales cannot be expected until the present industrial depression has passed.

The exchange situation of the last six years has practically eliminated American competition in many types of machine tools in several European markets, and as a result, a machine tool industry has developed, in France especially, and also in Belgium and Italy, which is capable of taking care of the regular standard lines of machines. More highly developed machine tools, however, are still in demand in all European countries, and many American machine tools can be sold in competition with the domestic product provided the price is not more than from 20 to 40 per cent above that of competing machines built by domestic manufacturers.

Wynmalen & Hausmann, of Rotterdam, express similar opinions. No great improvement can be expected for 1925. During the past years there have been enormous quantities of machine tools, mainly German, sold in the Dutch market at very low prices so that nearly all users of machine tools have stocks of machines on hand for which they have no immediate use. The Dutch industry also is hampered by many government regulations relating to working hours, insurance of workers, and extremely high taxes, making it practically impossible to interest capital to enter the industrial field. This, in addition to the high ocean freight rates, makes the sale of American machine tools very difficult.

Industrial Conditions in Sweden

One of the leading Swedish machine tool dealers reviews briefly the industrial conditions in that country. There was a complete industrial collapse at the end of 1920, and the year 1921 was the worst that has ever been experienced—all prices dropped, most factories closed, and those that did not entirely close, worked short hours. A gradual improvement has taken place during the last three years.

The especial difficulties met with in the machine-building field are the strong labor unions and the high wages, which make it impossible to reduce costs, so as to meet competition in the world's markets. The labor unions are practically supreme in determining the wage rates, and while the living costs are only about 70 per cent higher than before the war, wages have more than doubled, and in some instances are three times as high as they were ten years ago. As a result, many plants are still closed, others work short hours for a few days a week, and many have gone into bankruptcy. For that reason there is little or no demand for machine tools, as a great deal of the existing equipment stands idle, and furthermore, many machine tool

builders in Sweden have had big stocks on hand since 1920 which are not yet disposed of. The prospects for the future, therefore, are not promising, and better market conditions are not expected until wages have returned to the same level as living costs, for it would be impossible for the Swedish industry, which manufactures mainly for export, to sell its products to meet foreign competition.

Another well-known Swedish machine tool dealer does not expect any appreciable improvement until after one or two years, at best, as the market is filled both with new and second-hand tools which are now sold at very low prices, preventing business in high-class machines. Hence, the prospects for the importation of American machine tools are not very bright at present. The branches of the Swedish machine-building industry that show an increasing activity are the cream separator, ball bearing, and shipbuilding fields. In order to increase the interest in American machine tools in Sweden, it is necessary that the representatives be well acquainted with the specialized machines that may have a sale in the country.

Machine Tool Business in Germany and Austria

The industrial revival that will probably take place in Germany during the year 1925 as the Dawes plan becomes definitely operative, promises greater activity in the German machine tool trade, but as German machine tool builders in most cases are able to supply the domestic demand, there is no likelihood of an appreciable import trade from the United States, except in cases of gear-cutting machinery and other specialized production machines, which are not available on the German market. Some German manufacturers prefer certain types of American machine tools, and may insist upon obtaining these machines, but the market at best will be limited.

Recently, German competition in the European machine tool market has been of comparatively small importance, because German prices have been very high. Possibly this condition will change again as Germany adjusts herself to the new conditions made possible under the Dawes plan. There are still some German machines offered in the market at a low price—mainly machines that have been held in stock for some time and are being closed out at whatever they will bring—but for the moment the German machine tool industry is not able to take new orders at prices that offer any competition with the domestic product of other European countries.

Austria has passed through an economic crisis during the past year. The capacity of its industry, in different branches, is from four to eight times the domestic demand. The export trade is difficult because of the tariffs that prevent Austrian goods from passing freely into neighboring countries, and the internal conditions in Austria—high taxes and interest rates—make it difficult to conduct business on a normal basis. The prospects for the importation of American machine tools into Austria, therefore, are not favorable; the early part of 1925 will see a continuation of the present depression, while in the latter part of the year an improvement may be expected. One obstacle is that American machine tools cost about 80 per cent more than before the war, while the competing machine tools in the Austrian market now sell at from 10 to 30 per cent above the pre-war prices. This naturally tends to prevent sales, except of such special machines as are not built in Europe. Standard machine tools, such as lathes, drilling machines, shapers, plain milling machines and planers, are not likely to find a market in Austria in the future.

The Prospects in Czecho-Slovakia

Czecho-Slovakia emerged from the post-war crisis and depression a couple of years ago, but business is still at a low level, and plants are probably not run at more than 60 per cent of capacity. German competition in machine tools is very keen, and Germany is favorably located with relation to this market; hence, there is no likelihood of any importation of the standard American machine tools into this country. The types of machine tools of which America is practically the only producer will still be imported, but these are restricted almost entirely to automatic machines and gear-cutting and gear-grinding machines. These, however, are mainly employed in the automobile industry, and this industry is not very well employed.

Even though it might be possible to sell American machine tools, to some extent, both in Czecho-Slovakia and in Austria, it can be done only through dealers who are in a strong financial position and able to extend long credits to their customers. Such dealers hardly exist any more, because those who were in that position have gone into the manufacturing business themselves, and are building machine tools to supply the demand that, due to the crisis passed through, they were unable to supply with imported tools. Until the financial situation has righted itself and the industry in Central Europe has been able to place itself on a firmer basis, there is no great likelihood of any expansion in the importation of American machine tools.

The Machine Tool Market in Australia and New Zealand

The general prospects for the importation of machinery into Australia during 1925 are fair. Machine tool imports into Australia are only a small part of the general machinery imports, but are, as a rule, in direct proportion to the machinery trade in general, because they follow the business conditions as a whole; 1925 should be a fairly good year, because the harvest has been satisfactory, which means general prosperity for Australia. The demand for agricultural machinery is largely supplied by Australian manufacturers, but there will be some import demand for this type of machines, and also for excavating, road-making, textile, and mining machinery.

One of the leading machinery importers in New Zealand states that the coming year will see a fair demand for machine tools, automobiles, and certain types of domestic mechanical appliances, but outside of these lines the demand for American machinery will probably diminish, owing to the revival of British trade.

This dealer believes that the greatest obstacle to the American machinery trade with New Zealand is the high American tariff on the products that could be sold by New Zealand to the United States. The United States tariff on such raw materials as wool and flax that New Zealand sells, is so high that New Zealand cannot trade with the United States, while Great Britain, on the other hand, purchases 85 per cent of the products of New Zealand. "As trade is merely a matter of exchange of commodities," says this dealer, "how can any country expect to do business with another country if it does not reciprocate? The writer some time ago had a visit from a representative of the American Shipping Board, who clearly saw the position." In the long run, therefore, more and more of the machinery buying will be done in Great Britain, unless the United States elects to trade with, rather than merely sell in, New Zealand.

Export Possibilities in Japan

Japan offers probably the most active market for American machine tools in the near future. Unfortunately, even this market has been seriously restricted by the fact that Japanese exchange is now about 25 per cent below par and that, owing to the earthquake, Japanese credit conditions have not yet been fully restored. Native Japanese dealers also point out that the anti-Japanese legislation in the United States has to some extent, at least, been effective in turning orders to European machine tool manufacturers, especially to German and English makers. A complete review of the Japanese situation will be found in the article by S. Noda, president of Roku-Roku Shoten, Ltd., entitled "The Machine Tool Requirements of Japan," which will be found on page 350 of this number of MACHINERY.

Planetary Gearing

By FRANKLIN DeRONDE FURMAN
Professor of Mechanism and Machine Design
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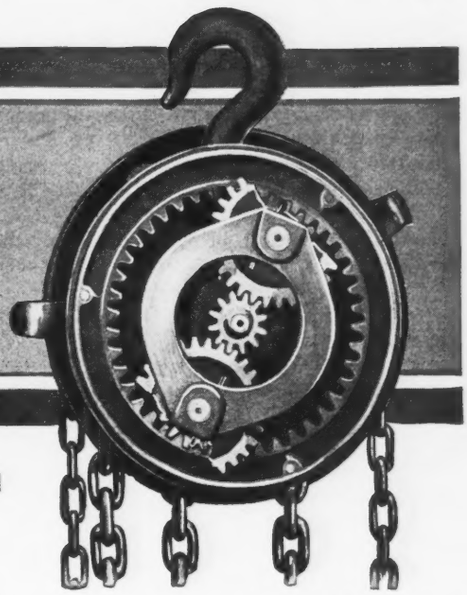


Use of Bevel Wheels and their Effect on the Analysis and Solution of Planetary Gearing Problems
Sixth Article

THE preceding article included a consideration of the effect produced, in the several methods of solution, by using different circular or diametral pitches for different pairs of mating gear wheels in a planetary gear mechanism. It was pointed out that the use of different pitches did not in any way affect the analytical method of solution so far as the arithmetical work is concerned, but that it might easily tend to lead to error in the mental processes that must precede the arithmetical work. This makes the graphical and geometrical methods all the more essential for checking, and in these two methods it is always necessary to revise one pair of pitch circles, as ordinarily laid down, before proceeding with the graphical construction. Graphical and arithmetical methods were explained for making this revision of one pair of pitch circles. The relations between circular and diametral pitches and pitch diameters were pointed out in so far as they enter into these planetary gear problems. In connection with the graphical solution, a special paragraph was devoted to the subject of proportioning by graphical methods. The notation follows:

N = number of turns of driver to one of follower or driven member;

N' = number of turns of follower to one of driver;

N_1 = number of turns of driver to one complete revolution of planet wheel axis;

N_2 = number of turns of follower to one complete revolution of planet wheel axis;

D = diameter of pitch circle of driver, if driver is a toothed wheel; (The driver or the follower may be the "train arm," and not one of the toothed wheels.)

D_1 = diameter of pitch circle of follower, if follower is a toothed wheel;

D_2 = diameter of pitch circle of the fixed wheel; and

D_3, D_4, etc., = diameters of pitch circles of planetary wheels.

Bevel Wheels in Planetary Gearing—Problem 18

The effect of introducing bevel gears in planetary gearing requires a special method of projection for representing the velocity lines in solutions made by the graphical method. This is due to the fact that the bevel wheels are illustrated in planes perpendicular to the paper instead of in the plane of the paper as is the case with spur wheels. The analytical or arithmetical method of solution is in no way affected by the introduction of bevel wheels in the general cases where the driver and follower wheels are the sun wheels. Should the planet wheel be the follower, a special analysis would be required. Several problems will now be taken up to illustrate these points.

Problem 18—All bevel wheels are to be used (see diagram Fig. 23); $D = 16$; $D_2 = 40$; and $D_3 = 27$. Solve for N by the graphical and analytical methods. In the example shown, G is the driving shaft, D the driving wheel, D_3 the planet wheel, D_2 the fixed wheel, T the train-arm and V the follower shaft.

Graphical Solution of Problem 18

In the graphical method of solution, let AB represent the tangential linear velocity of the large circle of the bevel wheel driver D. If AB_1 is the linear velocity of point A of the planet wheel D_3, PE will be the linear velocity of the center point of this wheel, because D_3 is in rolling contact with the fixed wheel D_2. The instantaneous center of the planet wheel D_3 is at C. The point P of the planet wheel travels in a circle whose radius is PM, and therefore the angular velocity of point P of the center of the wheel, and of the train arm T about FG as an axis will be measured by the expression $\frac{PE}{PM}$.

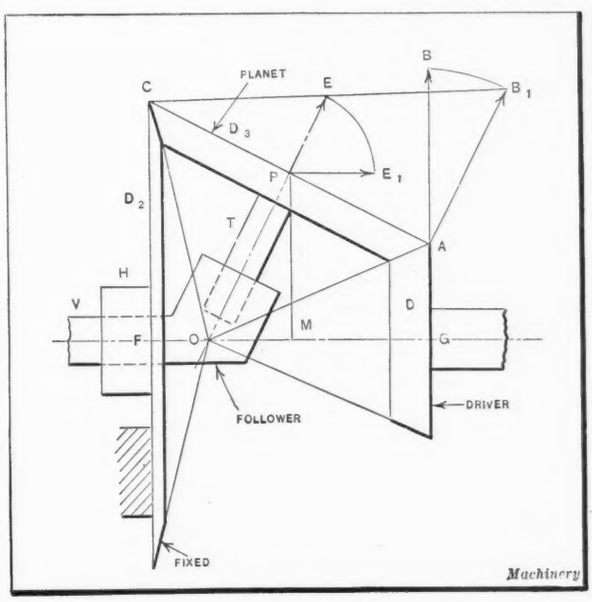


Fig. 23. Example illustrating Application of Bevel Gears to Planetary Gearing—Problem 18

This is also the expression for the angular velocity of the follower shaft V. The angular velocity for the driving shaft G is $\frac{AB}{AG}$. With these expressions known, it is only necessary to measure the lengths of the lines and substitute the measured values in the equation

$$N = \frac{AB}{AG} \div \frac{PE}{PM}$$

This gives an approximate result.

The direction of AB is shown radial in the illustration in

order to abbreviate the graphical construction. The labor of drawing an end view with a circle having GA for a radius and then drawing a tangent line equal to AB to the circle, is unnecessary, for all that one could then do with this drawing would be to lay off from it the distance AB at AB_1. The velocity line AB_1 falls naturally perpendicular to the paper at A, but it is necessary to imagine it revolved 90 degrees into the plane of the paper in order to work out the graphical construction on paper. The fact that this line is revolved, imposes a mental alertness throughout the entire graphical construction in order that the direction of turning of the several wheels may not be confused. In general, when AB is drawn upward, it indicates that the point in question is moving away from the observer, and when drawn downward, that it is moving toward the observer.

Analytical Solution of Problem 18

The analytical method of solution remains the same as in previous problems, and is briefly as follows: The entire mechanism is revolved once about the axis FG; hence $N = 1$. The direction of revolution will be considered clockwise, looking from the right. The fixed wheel only is next turned counter-clockwise one revolution while the axes of the other wheels remain stationary, thus causing D_3 to turn counter-clockwise and the wheel D to turn clockwise. The formula now stands $N = 1 +$, because the driving wheel D is turned additionally in a clockwise direction by returning the fixed wheel to its original position. The amount that D_3 is turned additionally is found by the expression: $\frac{D_2}{D_3} \times \frac{D_3}{D}$. Thus the complete analytical formula is:

$$N = 1 + \frac{D_2}{D_3} \times \frac{D_3}{D}.$$

Substituting the numerical values of D, D_2 and D_3 as given in the data,

$$N = 1 + \frac{40}{27} \times \frac{27}{16} = 3.5$$

Therefore the driving shaft G makes three and a half turns to one turn of the follower shaft V.

Humpage Planetary Gear—Problem 19

The Humpage planetary gear, a well-known bevel gear reducing mechanism, is illustrated diagrammatically in Fig. 24. The driving shaft G has keyed to it the driving wheel D, and at its end carries a free-turning sleeve V with a free-turning stud T to which is keyed the planet bevel wheels D_3 and D_4. The planet wheel D_3 meshes with a fixed bevel wheel D_2, and the wheel D_4 meshes with the follower-plate bevel-toothed gear D_1, which is keyed to the follower shaft H.

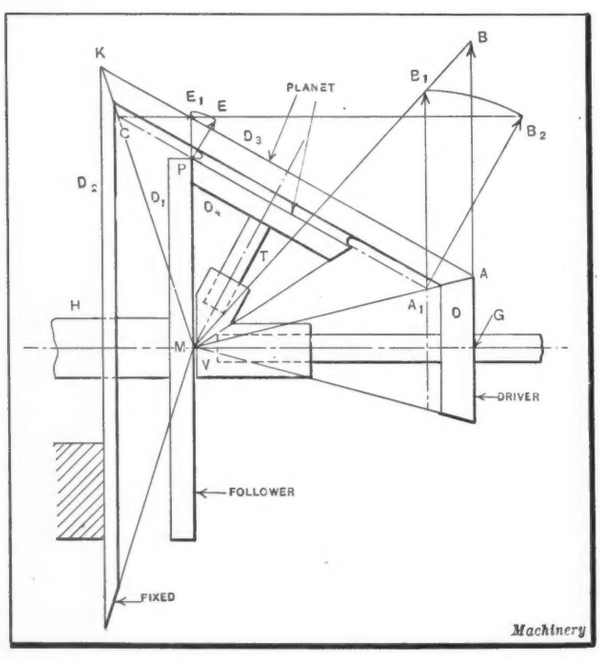


Fig. 24. The Humpage Bevel Type of Reducing Gear—Problem 19

Problem 19—The numbers of teeth on the respective wheels of the Humpage gear, Fig. 24, are as follows: $D = 30$; $D_1 = 80$; $D_2 = 120$; $D_3 = 90$; and $D_4 = 40$. Find the value of N.

The graphical method for solving the Humpage gear is as follows: Assume AB as the linear velocity at the point A on the driving wheel, as in the preceding problem. It is now to be observed that the planet wheels D_3 and D_4 are one solid mass comprising part of the pitch cone AMK, the point A of which is driven at the velocity AB, and the points K and M of which are stationary. It is also to be observed that it is the point P of the planet wheel D_4 that drives the follower wheel D_1, and that it is the motion of this point that must now be found. Since the point P is in the cone mass AMK, it must turn about C with a velocity PE proportional to the velocity A_1B_2 of the same cone. The latter velocity is equal to the velocity A_1B_1 of the point A_1 on the pitch cone of the driving wheel D. The velocity A_1B_1 is obtained from the assigned velocity AB by drawing the line MB. Since the linear velocity of P on the follower D_1 is PE_1, equal to PE, the angular velocity of D_1 is $\frac{PE_1}{MP}$. The angular velocity of the driver D is $\frac{AB}{AG}$. Therefore

$$N = \frac{AB}{AG} \div \frac{PE}{PM}$$

Analytical Solution of Problem 19

The analytical solution is found by obtaining first the number of turns of the driver per turn of the train arm T, and then the number of turns of the follower per turn of the train arm, and finally dividing the first by the second as follows:

$$N_1 = 1 + \frac{D_2}{D_3} \times \frac{D_3}{D} =$$

$$1 + \frac{120}{90} \times \frac{90}{30} = 5$$

$$N_2 = 1 - \frac{D_2}{D_3} \times \frac{D_4}{D_1} =$$

$$1 - \frac{120}{90} \times \frac{40}{80} = 1/3$$

$$N = \frac{N_1}{N_2} = 5 \times 3 = 15$$

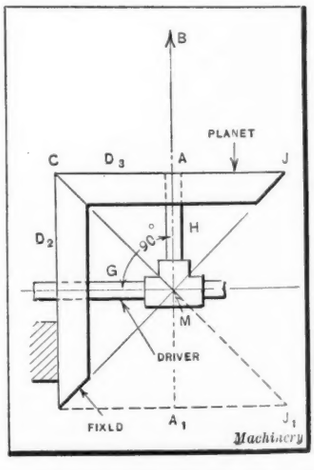


Fig. 25. Diagram illustrating Analysis of Bevel Planet Wheel Motion

It is thus found that the reduction in this gear is 15 to 1. With the Humpage gear, it is possible to obtain many other reductions, and even reverse motion, by simply changing the sizes for certain of the wheels. A definite guide for making such changes in the reduction is offered by a study particularly of the equation for N_2. If the sizes of the wheels D_1, D_2, D_3, and D_4 are so chosen that $D_2 \times D_4$ equals $D_3 \times D_1$, the value of N_2 will be zero, which means that the reduction will be infinite, or that the follower D_1 will remain stationary regardless of the speed or direction of turning of D. If the product of $D_2 \times D_4$ is less than the product of $D_3 \times D_1$, the value of N_2 will be a fraction with a plus sign, and the wheels D and D_1 will turn in the same direction. Conversely, if the product of $D_2 \times D_4$ is greater than the product of $D_3 \times D_1$, the value of N_2 will always have the

minus sign before it, and the follower D_1 will turn in the opposite direction from the driver D.

A close analysis of the two preceding problems in which bevel wheels were used will show that the stem of the planet wheel turns in its socket, as at O, for example, in Fig. 23. This turning, however, in no way affects the ratio of reduction between the driving and follower shafts, and hence is not recognized in either method of solution as given. This turning merely serves to permit such reduction when bevel planet wheels are used. The rate of this turning only needs to be determined when the planet wheel is the follower. Such a case would be analogous to the one in spur gearing where the problem consists in determining the number of turns that one circle makes while rolling about a fixed circle, or the more practical problem of the fixed sun circle and the two planet circles mounted radially on a train arm to form the basic mechanism of rope manufacturing machinery. This special case will now be further explained.

Analysis of Bevel Planet Wheel Motion

A planetary bevel wheel D_3 which turns freely on the train arm H is shown in Fig. 25. This arm is driven by the shaft G which passes freely through the fixed wheel D_2. If the center point A at the end of the train arm H has a velocity AB (which is shown vertically in the diagram but, in reality, is perpendicular to the paper), the angular velocity of the planetary wheel D_3 about C will be $\frac{AB}{AC}$, because C is the instantaneous center of the bevel wheel. This is also the angular velocity of D_3 on the train arm, because the motion of AB about C stationary is relatively the same as an equal motion at C with A stationary. The angular velocity of the train arm H about the horizontal driving shaft G is $\frac{AB}{AM}$. Therefore $N' = \frac{AB}{AC} \div \frac{AB}{AM}$. Measuring these values to any convenient scale,

$$N' = \frac{5}{4} \times \frac{4}{5} = 1$$

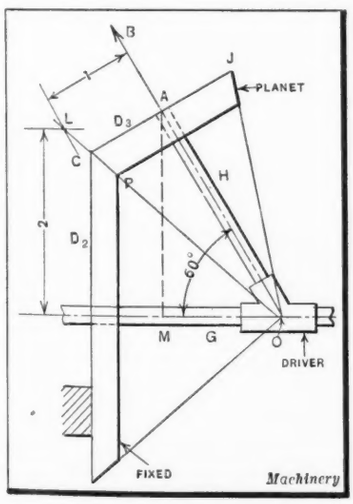


Fig. 26. Effect when Size of Bevel Planet Wheel differs from that of Fixed Wheel

In other words, the planet bevel wheel turns once on its own axis while the train arm turns once. Analytically the formula is written,

$$N' = 0 + \frac{D_2}{D_3} = 0 + \frac{20}{20} = 1$$

considering that there are 20 teeth on each bevel wheel. The zero that occurs in the formula and is characteristic of bevel planet wheels when set at 90 degrees, is written in because when the entire mechanism is given one full turn, neither the train arm H nor the planet wheel D_3 turns on its own axis, both axes coinciding; consequently there is zero turn of the follower planet wheel D_3 while the driving shaft G, train arm, and fixed wheel D_2 turn once. When D_2 is turned back, it gives $\frac{D_2}{D_3}$ turns to D_3 in the same direction in which the entire mechanism was originally turned. It is apparent that the planet bevel wheel D_3 turns only once on its own axis and once on the train arm, while the driving shaft G makes one turn. This differs from the corresponding case in spur gearing, where the planet wheel is a spur wheel that turns twice on its own axis and once on its pin while it rolls completely around a fixed spur gear of equal size, as explained in connection with Fig. 14 in the November installment of this series.

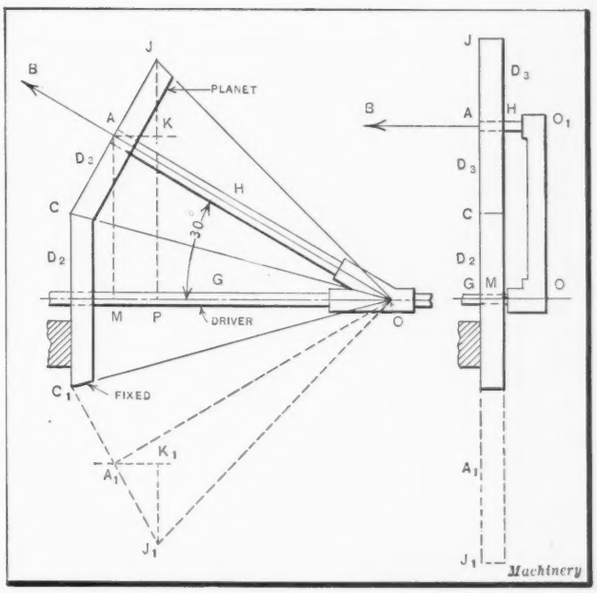


Fig. 27. Diagram illustrating how Motion of Bevel Planet Wheel is affected by its Inclination

Fig. 28. Diagram of Spur Planet and Sun Wheel for Comparison with Action of Bevel Planet Wheels

Bevel Planet Wheel Motion as Affected by Inclination of Axis

The action of the bevel planet wheel becomes somewhat more involved by the analytical method of solution when the angle between the wheel axes falls between 0 and 90 degrees. In Fig. 27 the angle between the wheel axes is 30 degrees as shown. The graphical solution is simple, as

$$N' = \frac{AB}{AC} \div \frac{AB}{AM}$$

The analytical solution for the case shown in Fig. 27 is written $N' = \frac{MO}{AO} + \frac{D_2}{D_3} = \cos 30 \text{ degrees} + \frac{D_2}{D_3} = 0.866 + \frac{20}{20} = 1.866$, it being assumed that there are 20 teeth on each wheel; hence the planet bevel wheel follower makes 1.866 turns on its own axis to one turn of the driving shaft G. The fraction $\frac{MO}{AO}$ in the formula is the ratio of the length of the projection of the planet wheel arm, or train arm, to the length of the train arm itself, and it represents the amount that the train arm H and the planet wheel D_3 turn on their own axis while the train arm turns once about G as an axis. This ratio will always represent a value falling between unity and zero, it being unity when spur wheels are used, in which case the train arm pin is parallel to the axis of the fixed wheel, and zero when 90-degree miter wheels are used, in which case the pin is vertical, as in Fig. 25. Thus, if the sun and planet wheels are the same size, the sun wheel being fixed, the planet wheel will turn once on its own axis while the axis itself revolves once around the sun wheel axis, when these axes are at 90 degrees; when at 60 degrees, the planet wheel turns 1.5 times; when at 30 degrees, 1.866 times, as shown by the preceding example, and when the axes are parallel, as they are in spur wheels, the planet wheel turns twice on its own axis while it rolls once around the fixed sun wheel.

The *simple revolution* of a spur wheel, such as at D_3 in Fig. 28, about an axis G which is outside of the spur wheel, causes the wheel to rotate once on its own axis, D_3 being considered as independent of D_2. This is indicated by J which is directly above the center A at the start, and directly below the center A after the wheel has been revolved

180 degrees, as shown at J_1 and A_1. Following this a little closer so as to supply an analogy for a subsequent discussion regarding bevel wheels, it is to be noted that as the wheel D_2 revolves about G as an axis, the points J and A must have the same angular velocity, which means that the linear velocity of J will be greater than the linear velocity of A in the ratio $\frac{JM}{AM}$. It is this excess of velocity of J over A that causes J to rotate with respect to A.

In Fig. 27 the train arm H and the bevel planet wheel D_3 also have a component motion of revolution about G, and the points J and A have the same angular velocity about G. Therefore, the linear velocity of J will be greater than the linear velocity of A in the ratio $\frac{JP}{AM} = \frac{JP}{KP}$. This excess linear velocity of J gives J an angular velocity with respect to A less than its angular velocity with respect to K in the ratio of $\frac{JK}{JA}$. Therefore this last ratio represents the rate of turning of the point J of the planet bevel wheel with respect to its center point A, in terms of the angular velocity of the center A about G. It remains now to point out that the triangle AJK is similar to the triangle AOM, each being right triangles having their respective sides perpendicular to each other. Ther fore $\frac{JK}{JA}$, as deduced above, equals $\frac{MO}{AO}$ as used previously in the analytical formula.

When Size of Planet Bevel Wheel Differs from that of Fixed or Sun Wheel

The sun and planet bevel wheels in Figs. 25 and 27 are of the same size, and for this reason the pitch cones of the bevel wheels are of the same size. If, however, the two wheels are of different sizes, so as to give a velocity ratio of, say, 2 to 1, the angles of the pitch cones will not be 2 to 1. In such cases as this, it is the tangents of the pitch cone angles that vary as the sizes of the wheels, and not the angles themselves. This is illustrated in Fig. 26, in which the fixed wheel D_2 is twice the size of the planet wheel D_3, and the angle between the shafts is 60 degrees. The first step in laying out the wheels is to draw a line parallel to H and one unit away from it; then another line parallel to G and two units from it. These two lines intersect at L, and if a line is now drawn through O and L it becomes the tangent line of the pitch cones, and the wheels themselves may be cut at any radial distance out, as at CP, according to the size desired.

The graphical and analytical solutions for the turns of the bevel wheel D_3 in relation to the turns of the driving shaft G are the same in principle as described in connection with Fig. 27, and are as follows:

Graphical solution:

$$N' = \frac{AB}{AC} \div \frac{AB}{AM}$$

Measuring these values to any desired scale,

$$N' = \frac{4}{3.5} \times \frac{8.7}{4} = 2.5 \text{ approximately}$$

Analytical solution:

$$N' = \frac{MO}{AO} + \frac{D_2}{D_3}$$

The value $\frac{MO}{AO}$ is a measure of the cosine of the 60-degree angle between the shafts, and is equal to 0.5. If the wheels D_2 and D_3 have 40 and 20 teeth, respectively,

$$N' = 0.5 + \frac{40}{20} = 2.5$$

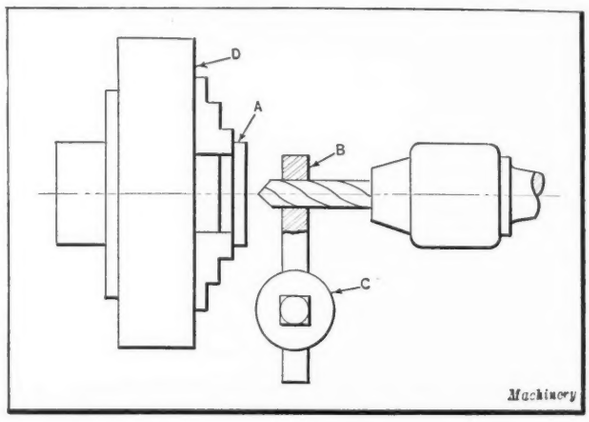
PRODUCTION DRILLING IN A LATHE

By DONALD A. BAKER

With no drill jig available, the drilling of the hole in the casting A shown in the illustration would ordinarily be considered a job for the hand screw machine, and the set-up would be a spotting drill to start the hole true, followed by an ordinary twist drill. However, as several hundred of these castings were required on a rush job at a time when no screw machine was available, it was necessary to drill the pieces in an engine lathe.

In preparing for this job, a center drill was chucked in a three-jaw universal chuck D and a piece of steel B clamped in the toolpost C, as shown in the illustration. The piece B was spotted with the center drill, and then drilled with the same drill that was later used in drilling the work. This method insured having the hole in piece B lined up accurately with the center of the lathe spindle.

In operation, the work was chucked in the regular way, while the drill was held in a chuck carried by the lathe tailstock spindle. As the end of the drill was supported and



Drill supported by Piece held in Toolpost

guided by the piece of steel B, a spotting drill was unnecessary and the work was done in one operation. With this arrangement, an unskilled girl was able to perform the drilling operation on the parts in a satisfactory manner.

* * *

THE FORGING INDUSTRY IN 1923

The figures pertaining to the Census of Manufactures for 1923, recently released by the Department of Commerce, show that the forging plants of the country produced about $179,000,000 worth of forgings, an increase of 115 per cent as compared with 1921, the last preceding census year. There were 223 establishments engaged in forging work in 1923, of which 48 were located in Pennsylvania, 36 in Ohio, 27 in Illinois, 25 in New York, 18 each in Connecticut and Michigan, 13 in New Jersey, and 11 in Massachusetts, the remaining being scattered over 13 states. The average number of wage earners in this branch of the metal-working industry was 27,400, and the wages paid during the year, slightly over $40,000,000.

* * *

The development of the industries of the United States at the expense of agriculture is best indicated by the fact that today there are fewer persons engaged in farming than there were fourteen years ago, while on the other hand there has been an increase of 20,000,000 in the number of people living in cities and towns since 1910. In spite of the fewer people engaged in agricultural pursuits, there has been a considerable increase in the volume of agricultural products, and in this respect, the industrial development has been paralleled by a development of greater efficiency in agriculture.

What Our Readers Think

on Subjects of General Interest in the Mechanical Field

HONING AUTOMOBILE CYLINDERS

The series of articles that have appeared in MACHINERY giving opinions on automotive plant production problems, including that of honing cylinder bores, induces me to give my opinion, based upon a complete research on revolving and reciprocating types of honing devices, with proper design of holders for the stones.

My belief is that round and straight bores cannot be obtained without grinding and honing the cylinder blocks To hone properly, the experience of the Lincoln Motor Co. has been that the reciprocating type of hone is superior to the revolving type, because the grain of the cylinder surface should be laid in the same direction as the operation of the piston. The hone is indexed unevenly at the bottom of each stroke to break up the paths of the stones. The revolving type of hone follows the same path as the grinding wheel, and it is left to the piston to provide for itself a proper wearing surface.

The stone-holder is so mounted that it is under a radial compression of from 15 to 20 pounds. This compensates for the wearing of the stone. A dummy holder is used to "diamond-off" the stones to give a proper bearing.

O. E. HOVEY

* * *

NEW IDEAS ON ENGINEERING EDUCATION

I read with interest the article in October MACHINERY, page 142, entitled "New Ideas on Engineering Education." Frequently I have heard men connected with educational institutions state that there is an increasing tendency to eliminate shop work from the school curriculum. While my understanding of the subject is slight in comparison with that of men having engineering experience, as I am merely a student, I cannot understand why they wish to eliminate these courses.

The authority quoted states that he would give the student four years of physics. That would be very well, but is it not done indirectly? The different technical courses given are largely specialized branches of physics with some practical applications. Why should all engineers take chemistry four years when many of them know that they will make no practical application of their knowledge of this subject in the work they expect to do? Many students would not take an engineering course if they were required to take four years of chemistry.

The other studies mentioned are valuable, as they broaden the mind and give a better understanding of the world in general. But what is the advantage of studying foreign languages when the tendency of all educated men is to learn the English tongue? Why leave out all mention of law study? However, to get back to the practical side of engineering, from what I have seen, no attempt is being made to familiarize the student with the details of any industry. In fact, it would be impossible to do so unless the student specialized on one subject only.

But why should the practical side of engineering be entirely ignored? Is it not better to show the relationship between science and practice rather than to force the student to connect it all afterward when he is trying to get a start in his chosen field? Would it not be better if it were possible to inspect outside projects and industries and so become familiar with the real problems of the engineer?

All too often we find designs made by engineers having a purely scientific education and no practical experience. These designs prove a source of unnecessary expense, because there is not a sufficient understanding of what is and what is not practicable to manufacture. Frequently parts of machines designed under these conditions cannot possibly be assembled, or, if assembled, cannot be disassembled without damage to the machine or the parts.

Some are of the opinion that an engineer need not be a designer. Perhaps this is so, but it seems sometimes that a designer should be more of an engineer. It is an impossibility for all who study engineering to be consulting engineers. Many will have to be content with lesser positions, so why not give the student enough practical work to enable him to at least obtain a job when he has completed his engineering course? Employers are rather reluctant to hire a man who has had no practical experience.

CHARLES W. WALKER

* * *

REDUCING PRODUCTION COSTS

The importance of having machine parts so designed that they can be easily and cheaply produced is appreciated by every designer and production engineer. In spite of this fact, we can find parts on nearly every large machine that could be produced at less cost either by making changes in design, by employing different machining methods, or by using a different material.

For instance, there are many cases in which "conventionality" seems to be the only reason for employing machined parts instead of sheet-metal stampings. Small ring gears, for example, can often be produced much cheaper from heavy tubing than from solid bar stock. Sometimes the casting for a certain part may be so frail in structure or of such shape that it appears necessary to hold it in a special type of fixture. A careful consideration of the problem, however, might show that temporary lugs could be cast on the part which would permit it to be held in a regular chuck instead of requiring an expensive fixture.

Again, there are cases in which two or more parts can be cast as one piece and the pieces cut apart after all or a number of the machining operations have been performed. These methods are not representative of general practice, however, and for that reason are often overlooked when they might prove to be the means of facilitating production or substantially lowering production costs.

It is, of course, rather difficult in some cases to decide, without actual trial, what method of machining or what material will be the cheapest in the long run. For example, one kind of material may cost much less than another, but the difference in cost may be more than offset by the higher upkeep cost of the tools used to machine the cheaper material. While production kinks such as mentioned may seem rather insignificant, their proper application has resulted in substantial savings in many plants. The exchange of practical, yet unusual ideas and methods such as these through the medium of MACHINERY is a service that has come to be of great value to the machine-building industry. C. F.

* * *

A recent copy of "German Trade Reports and Opportunities," published by the American Chamber of Commerce in Germany, shows that in August, 1924, the composite price index of sixteen articles in the coal, iron, steel, and nonferrous metal fields was 131.6, as compared with 100 in 1913. The composite price index for twenty-two articles of manufactured industrial products was 135.2, these prices being based upon a gold mark equal to 23.8 cents.

GURLEY'S BRONZE

Gurley's bronze is used for the framework for surveyors' instruments, and similar purposes. It contains 16 parts of copper; 1 part of tin; 1 part of zinc; and ½ part of lead. The tensile strength is about 40,000 pounds per square inch; the elongation, about 25 per cent in 2 inches; and the specific gravity, about 8.7.

MOTORS OF HIGH-SPEED TYPE

The development of the high-speed induction motor for direct application to machine tools has been of great importance to the machine tool industry. Moderate and high-speed motors are now applied to the same machine, the high-speed motor generally being used to drive the cutting tool, and the slower speed motor to drive the feeding mechanism. High-speed motors are of the same construction as the standard squirrel-cage motors. The speeds of these motors may range from 3600 to 18,000 revolutions per minute, and it would be feasible to obtain higher speeds if required commercially. In high-speed induction motors, the ratings are based on a continuous duty with a temperature rise of 50 degrees C. The motors are designed to operate at either 120 cycles, both 110 and 220 volts, or 200 cycles, 110 volts. Probably the majority of motors used in the machine tool industry are of the two-, four-, six-, or eight-pole type. The synchronous speed of an alternating-current motor is obtained by dividing the number of alternations per minute by the number of poles. For example, consider a two-pole motor operating on a 60-cycle circuit. Sixty cycles is equivalent to 7200 alternations per minute, and dividing this number by 2, the motor speed is found to be 3600 revolutions per minute. Since a motor cannot have less than two poles, 3600 revolutions per minute is the maximum speed that can be obtained on a 60-cycle source of supply. In order to obtain the higher speeds, it is necessary to increase the frequency or the number of cycles per second.

CELSIUS THERMOMETER

This thermometer, also known as the "Centigrade" derives its name from its inventor, the Swedish astronomer Celsius, who, in 1742, described a thermometer provided with 100 graduations between the freezing and boiling point of water. On the Centigrade thermometer scale, the zero point is placed at the freezing point of water, and the graduation "100" coincides with the boiling point of water; hence, the zero on the Centigrade scale corresponds to the 32-degree graduation on the ordinary Fahrenheit thermometer, and the 100-degree graduation on the Centrigrade scale corresponds to the 212-degree graduation on the Fahrenheit scale.

CHAIN MATERIALS

The best material for crane and hoisting chains is a good grade of wrought iron, in which the percentage of phosphorus, sulphur, silicon, and other impurities is comparatively low. The tensile strength of the best grades of wrought iron does not exceed 46,000 pounds per square inch, whereas mild steel with about 0.15 per cent carbon has a tensile strength nearly double this amount. The ductility and toughness of wrought iron, however, is greater than that of ordinary commercial steel, and for this reason it is preferable for chains subjected to heavy intermittent strains, because wrought iron will always give warning by bending or stretching, before breaking. Another important reason for using wrought iron in preference to steel is that a perfect weld can be effected more easily.

DRAW-BENCHES

Two types of machines are generally used for drawing shafting and screw stock. The first of these is known as the "straight draw-bench," on which a straight rod is drawn through the die by means of tongs on a head which travels in a straight line along the draw-bench, power being furnished by an endless sprocket chain or by hydraulic pressure. The second type is the bull-block machine, on which the rod is in the form of a coil that is carried on a reel at one end of the machine; the end of this rod is pointed and threaded through the drawing die, and gripped by tongs carried on a second reel, which rotates in such a way that the rod is drawn through the die and wound up on the second reel.

CEMENTS FOR JOINTS

A strong cement, which is oil-proof, waterproof, and acid-proof, consists of a stiff paste of glycerin and litharge. These form a chemical combination which sets in a few minutes. If a little water is added, it sets more slowly, which is often an advantage. This cement is mixed when required for use. A cement which withstands hydrochloric acid vapors consists of rosin, 1 part; sulphur, 1 part; fireclay, 2 parts. A cement composed of boiled linseed oil and fireclay acts well with most acid vapors. A composition of glycerin and litharge is useful in this connection, especially when made up according to the following formula: Litharge, 80 pounds; red lead, 8 pounds; "flock" asbestos, 10 pounds. It should be fed into a mixer, a little at a time, with small quantities of boiled oil (about six quarts of oil being used). Sockets in 3-inch pipes carrying nitric acid, calked with this preparation, showed no leaks in nine months.

MECHANICAL DRAFT

Mechanical draft is often employed as a substitute for a tall chimney, and also in case a boiler plant is increased beyond the capacity of the original chimney. Again, certain kinds of low-grade fuels require a stronger draft than is provided by a chimney of ordinary height. Forced draft is also necessary for mechanical stokers of the under-feed type. In a general way, the advantages of mechanical draft are as follows: Increase of boiler capacity, as well as efficiency, which is due to the more intimate mixture of the air with the fuel, when under pressure, thus making it possible to carry deeper fires; ease of regulation, and the ability to provide just the right amount of air for complete combustion; the use of poorer grades of fuel than can be burned with a natural draft; and the possibility of forcing the boilers, if necessary, without regard to outside weather conditions. Forced draft also permits the use of feed-water heaters in the smoke flues, which cool the chimney gases to a comparatively low temperature, and which would interfere with the natural draft of a chimney. The cost of the equipment for mechanical draft is also considerably less than for a chimney.

WATER-PACKING

The pistons of dashpots and similar apparatus that must move with a minimum of frictional resistance are commonly grooved to reduce the slip or leakage of liquid past the piston, but packing rings are not used. The grooves are generally called "water-packing" grooves, because water, oil, or other liquid under pressure accumulates in the grooves, and by capillary attraction and the setting up of eddy currents, materially reduces the leakage of the fluid without causing much frictional resistance.

COKE PRODUCTION

Coke is a product obtained by heating coal in air-tight retorts to such a temperature that the volatile constituents are driven off; hence, coke consists mainly of carbon, together with the incombustible materials or ash contained in the coal, and also small amounts of oxygen, hydrogen, and nitrogen, generally not exceeding 2 or 3 per cent. Coke, when produced rapidly and at a low heat, as in gas making, is of a dull black color, igniting with comparative ease, but when produced by long-continued heat, as in making coke for iron and steel melting, it is hard and dense, has a brilliant luster and silver-gray color, and will only burn in furnaces provided with strong draft. This quality is brittle and hard. One pound of coal will yield from 0.35 to 0.90 pound of dry coke, depending upon the kind of coal from which it is made. Coke is an important fuel in blast furnaces and foundries, but its cost is high, and for that reason it is not used for power plant purposes. Coke is classified either as foundry coke or furnace coke. Foundry coke is that which has been burned for 72 hours. It is hard and large and has a brittle surface. It is used for cupolas for melting iron and in large forge furnaces. Furnace coke is that which has burned for 48 hours. It is sometimes used in cupola practice, but its main usage is for smelting ores in blast furnaces. The standard quality of foundry and furnace coke should not contain more than 13 per cent of ash, and not more than 1 per cent of sulphur.

MAGNETIC ATTRACTION

The law governing the attractive or repulsive force of magnetism is the same as that which applies to gravity. When the distance between two magnetic poles is doubled, the intensity of the magnetic field is diminished to one-fourth; if tripled, the intensity of the field is reduced to one-ninth, etc. In other words, the attractive or repulsive force varies inversely as the square of the distance between the poles, it also varies proportionately as the product of the strength of the poles.

HOBS OF MULTIPLE-THREADED TYPE

Hobs that have a single-thread or row of teeth are generally used for cutting spur gears, but multiple-threaded hobs are sometimes employed. In using a multiple-threaded hob, it is necessary to change the ratio of the gearing controlling the relative speeds of the hob and the work, in proportion to the number of threads in the hob. For instance, if driving and driven change-gears having a 3 to 4 ratio are used for a triple-threaded hob, the ratio for a single-threaded hob would be 1 to 4. In view of the fact that a single-threaded hob must revolve as many times per revolution of the gear as there are teeth in the gear, whereas a triple-threaded hob, for example, revolves only one-third that number of times, it is evident that much greater production is obtained with multiple-threaded hobs, assuming that the same rate of feed is maintained. Notwithstanding the relatively high production obtained with multiple-threaded hobs, the single-threaded type is preferable for hobbing spur gears, as a general rule, because it generates more accurate teeth. This is due to the fact that a multiple-threaded hob has a larger helix angle than one with a single thread, unless the diameter of the multiple-threaded hob is increased in proportion to the number of threads. Because of this difference in the angle of the helix along which the teeth are located, the cutting action and the form produced are different, assuming that the teeth are the straight-sided rack-shaped form commonly used.

CHARACTERISTICS OF CAST IRON

Cast iron may generally be assumed to have an ultimate tensile strength of 15,000 pounds per square inch, an ultimate compressive strength of 80,000 pounds per square inch, an ultimate shearing strength of 18,000 pounds per square inch, and a modulus of elasticity of 12,000,000. At about 900 degrees F. cast iron retains about 75 per cent of its original strength, and at 1100 degrees F., 40 per cent. The strength begins to decrease at about 500 degrees F. The specific gravity of cast iron is about 7.2, the weight per cubic inch being 0.26 pound. Cast iron melts at about 2300 degrees F. Its linear expansion per unit length, due to heat, per degree F. is 0.00000556. Cast iron is probably the most complex, variable, and uncertain form in which iron is used. Not only is the amount of extraneous metals and metalloids variable, but the condition in which the associated carbon exists, and the character of this association, are determined largely by the influence of silicon and possibly other metalloids. Again, the physical properties of the metal are influenced by the casting temperature, rate of cooling, etc., so that the probable strength and stiffness of a casting can be estimated only in a general way.

BEARING VALUE OF ALLOYS

The essential characteristic of all bearing alloys is a structure made up of alternately hard and relatively soft microscopic particles intimately mixed. The softer crystals are more readily abraded and therefore wear slightly below the surface of the bearing crystals, thus forming slight depressions which serve to retain the lubricant. For example, it is entirely due to the dissimilarity of crystals in bronze that it makes a better bearing alloy than brass.

GLASS THAT IS NON-SHATTERING

A triplex non-shattering glass that will resist shock, is made by placing a thin sheet of xylonite between two sheets of glass and causing them to adhere by a special process under heat and pressure. The glass is transparent, sound-proof, air-tight, and water-tight even when badly cracked. A number of panels of the glass varying from ½ to 1 inch in thickness were subjected, one at a time, to the fire of a 45-caliber automatic pistol at ranges varying from 1 to 15 feet. The bullet penetrated only about 1/32 inch and was torn to shreds. Thinner panels, when subjected to this test, showed that some of the glass became detached from the reverse side, but in the case of thicker panels the reverse surface crumbled at the center and fell out in powdered form, but did not fly. This glass is particularly adaptable for safety goggles for workmen in steel mills and other industrial plants. It can be substituted in every case where common glass is ordinarily used.

COLD SHUTS

A cold shut is caused by the imperfect uniting of two or more streams of molten iron flowing together, which are too cold to coalesce. Such a fault often occurs on the upper side of a thin cylinder cast horizontally, when the iron is not sufficiently hot at the instant of pouring. It appears as a seam in the side of the cylinder, and it is very apparent that the metal has united imperfectly. Such a defect will cause the casting to split if subjected to any great stress, and it will leak under pressure. This imperfection is generally due to thinness of the metal or to improper gating. If the iron flows in thin streams for comparatively long distances, it will be cooled very much, and probably the advancing face will be partially solidified.

Notes and Comment on Engineering Topics

Chrome iron having rust-proof properties is reported to have been manufactured in Sweden. The new alloy is of a silver white color and has all the characteristics of soft iron. It is made by mixing Swedish iron with a certain amount of ore coming from South Africa. A roof covered with this material, it is estimated, will cost only 50 per cent more than one made from galvanized iron. The new roofing does not require any painting to protect it from rusting.

Hafnium, a newly discovered element, has certain characteristics that may make it of value in the radio industry for use in vacuum tubes. This element is found in all zirconium minerals in amounts ranging from 2 to 20 per cent, and is sufficiently abundant to be available for commercial purposes. It is also present in so-called commercially pure zirconium oxide and salts of zirconium. In chemical properties, it closely resembles zirconium. It has a very high melting point and high power of light emission.

The longest suspension bridge in the world is being erected across the Delaware River to connect Philadelphia and Camden. The total length of the bridge, including plazas, is 9760 feet as compared with 5989 feet, the length of the Brooklyn Bridge. The two cables supporting the bridge contain 25,000 miles of wire, enough to encircle the globe. This wire has been shown by tests to have a tensile strength of 223,000 pounds per square inch of gross section, and the cables will be able to sustain a load of 36,000,000 pounds.

Double-acting Diesel engines have recently been developed for ocean-going vessels. The first British double-acting two-cycle Diesel engine is now being installed in an ocean-going vessel, and three more are under construction. The Burmeister & Wain Co. in Copenhagen are building a double-acting four-cycle engine of 6750 brake horsepower, and Harland & Wolff of Belfast have under way a still larger unit. Single-cylinder, 1000-horsepower, double-acting two-cycle engines have also been constructed in Germany and Italy.

The route between New York and Buenos Aires will be shortened 450 miles by the construction of a new South American transcontinental railroad, which will soon be completed. The new road will extend from the present northern Argentine system to Atocha in Bolivia, where it will join a line that connects with northern Chile and Peru. Thus Bolivia will have access to the east coast, La Paz being brought within three and one-half days of Buenos Aires. The new route from New York will be via the Panama Canal, down the west coast of South America, and across on the new line.

The possibilities of the coining type of press as a means of speeding up the production of automobile parts have recently aroused widespread interest among production engineers. It has been shown that forged arms, levers, and similar parts having surfaces or bosses that would ordinarily require machining can be squeezed to size in a coining press with the same degree of accuracy as is accomplished by the removal of the surplus stock in cutting operations. Records of carefully made tests tend to show that no difference in the molecular constituency of the parts results from the squeezing operation.

The possibility of producing paints that will minimize the effects of fire and keep it from spreading is an important problem in connection with the painting of wooden buildings. The use of paints containing borates, ammonium phosphate, etc., has been suggested, but these paints deteriorate under the effects of the weather, owing to the presence of the water-soluble substances. The most satisfactory paint for this purpose, it is said, is one containing a maximum of pigment to reduce the inflammability of the oil, the pigments themselves being entirely mineral materials and free from organic substances. This limits one to paints made with earth colors reduced with barytes. However, the possibility of devising a paint that will be non-inflammable and at the same time will withstand exposure to weather appears to be quite remote.

The average price of locomotives bought by the railroads of the United States was 124 per cent higher in 1923 than in 1910 to 1914. A similar comparison for freight cars shows an increase of 103 per cent for all-steel cars and 109 per cent for composite construction. The increase in passenger car costs was 94 per cent. These prices are figured on a per-pound basis and do not make allowance for the increase in size of equipment that has taken place during the period covered. In the same period the passenger fares on most railroads have increased 80 per cent; freight rates have increased varying amounts, according to the class of freight handled, but in most instances the increases have not been so great as the increases in the cost of equipment.

In New York City alone there are 265,000 passenger automobiles, 79,000 motor trucks and 20,000 omnibuses in use. In 1916 there was one motor vehicle for each 45 inhabitants; in 1923 there was one for each 16 persons. The congestion caused by this tremendous number of motor vehicles presents an engineering problem that will tax the ability of the best engineers who have devoted themselves to city transportation problems. Possibly, New York City some day will have to do what Paris has done for nearly a hundred years past—acquire sufficient land for the opening up of great new avenues to care for the increasing traffic, and pay for the improvements by the resale of the acquired adjoining real estate at the enhanced value caused by the improvement made by the city.

Experiments conducted in the Research Laboratory of the General Electric Co., Schenectady, N. Y., have made it possible to produce single crystals of copper ⅞ inch in diameter and 6 inches long, as well as numerous smaller crystals of the same metal. These crystals have some very remarkable properties. A piece of copper about the size of a lead pencil, if given a jerking motion, bends as easily as a stick of soft wax; it cannot be bent back, however, any more easily than a similar piece of ordinary copper. When the copper is a single crystal, all of the atoms are arranged in columns, equally spaced. When the bar is bent, the spacing is changed, the atoms on the inside curve being pressed together, and those on the outside spread apart. Strains are set up and the crystal structure is altered. The bar becomes an ordinary piece of copper, of smaller crystals facing in all directions. Externally, the large single copper crystals differ little from regular copper in appearance. As yet, nothing has been made public as to the uses that these large crystals of copper may have in the industries.

Universal Measuring Machine

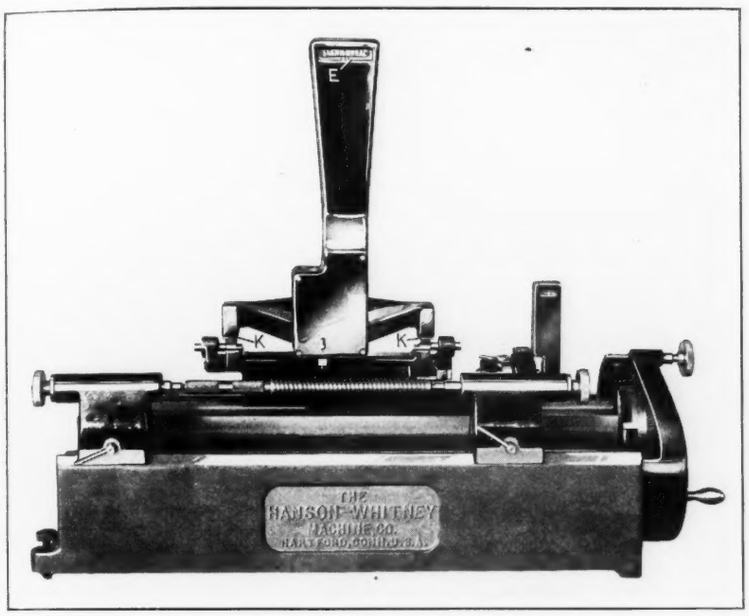


Fig. 1. Hanson-Whitney Universal Measuring Machine

THE accompanying illustrations show an improved measuring machine known as the Hanson Whitney universal type, which has been brought out by the Hanson-Whitney Machine Co., Hartford, Conn. The machine is in part a comparator and in part a direct measuring machine using a precision screw and a large graduated measuring wheel and vernier for obtaining accurate measurement. Briefly, the machine compares the dimensions to be measured with Johansson precision blocks; and if there are any small variations from the dimension of the measuring blocks, the amount of this variation is determined by means of the graduated measuring wheel *A*, Fig. 2, which is provided with a vernier *B*.

The application of the measuring machine may be best understood from an actual example. Assume that, in Fig. 2, it is desired to check the lead of a tap *C*. The slide carrying the measuring point *D*, which enters the thread as shown, is first so adjusted by means of the precision screw and nut in the rear of the machine that the indicator *E* at the top of the projecting arm shown in Fig. 1, points to some even division. This adjustment is obtained by means of the handle *F*, Fig. 2, of the graduated wheel *A* and the adjusting knob *G*, the handle *F* being used for rough adjustment, and knob *G* for the final setting. The indicator *E*, Fig. 1, is so mounted that it multiplies the movement of the measuring point 250 times, and each graduation on the scale at the top of the projecting arm represents a movement of the measuring point of 0.0001 inch.

After the slide has been set as mentioned, a sensitive indicating device, with an indicator *H*, Fig. 2, is brought up against an anvil *I* on the slide, and is adjusted until a drop-pin *J*, similar to that used on standard forms of measuring machines, indicates that a uniform measuring pressure on the anvil has been obtained. The projecting arm with the scale *E*, Fig. 1, is then rocked backward on the scale edges *K* a sufficient amount to permit the measuring point *D*, Fig. 2, to clear the tap. The slide containing the measuring point arm is next moved a predetermined amount, which is measured or gaged by the insertion of precision measuring blocks between the anvils that gage the adjustment. In this case only one gage-block *L* is used.

The rocking lever is then brought down again so that the measuring point enters between two threads. The distance between these threads and the threads first engaged by the measuring point *D* is supposed to be equal to the dimension of the precision block *L*. If the lead of the tap is accurate, the indicator on the projecting arm at the top of the measuring machine will point to exactly the same graduation as it did when point *D* engaged the thread the first time, before the position of the slide was changed. If the lead is out a certain amount, the indicator will show the discrepancy. However, this indicator scale is not depended upon to give the exact reading of the error. For this purpose the measuring wheel *A* and vernier *B* (shown most clearly at the right in Fig. 2) is used, the measuring screw being turned slightly to move the measuring slide enough to bring the indicator back to the predetermined position. The amount of this movement is read off on the graduations on the measuring wheel and its vernier.

It will be seen that in this way the main measurement is a direct comparison with the measurement of a precision gage-block, and that the measuring screw, measuring wheel, and vernier are depended upon only for measuring the few ten-thousandths of an inch by which the measured object may vary from the exact size of the precision block. The measuring screw is hardened and ground and the lead is accurate within 0.0001 inch per inch, but as the distance measured by the screw is only a very small part of an inch, it is evident that any error that may be present in the measuring screw is entirely negligible in the application of the device, as the error would have to be expressed in millionth

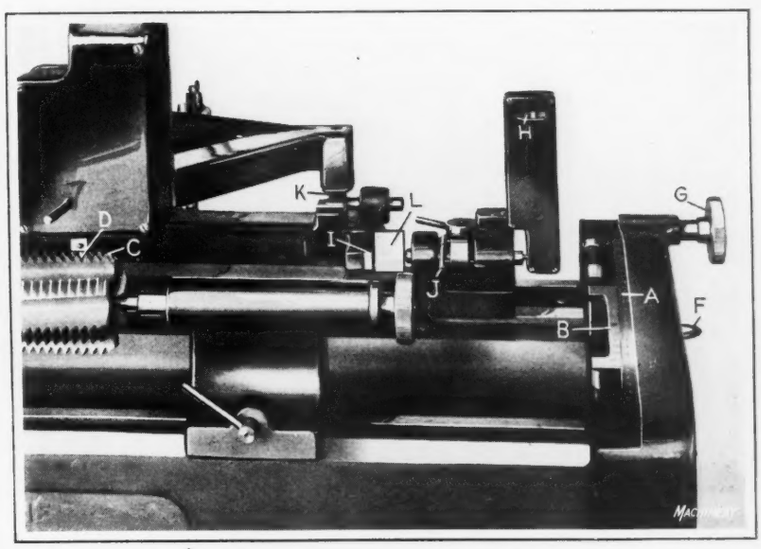


Fig. 2. Testing Lead of Tap Thread

parts of an inch. The vernier used in conjunction with the measuring wheel reads to 0.0001 inch, and as the graduations are quite large, it is possible to estimate accurately to within one-quarter of this value.

The precision screw is hardened and ground and the nut with which it engages is made from cast iron. This combination permits the screw to maintain its accuracy for a long period. The indicator *H*, shown at the right of the machine in the illustration, is a kind of danger signal, the point of which begins to move when the slide containing the drop-pin is within 0.001 inch of the position at which the pin will drop.

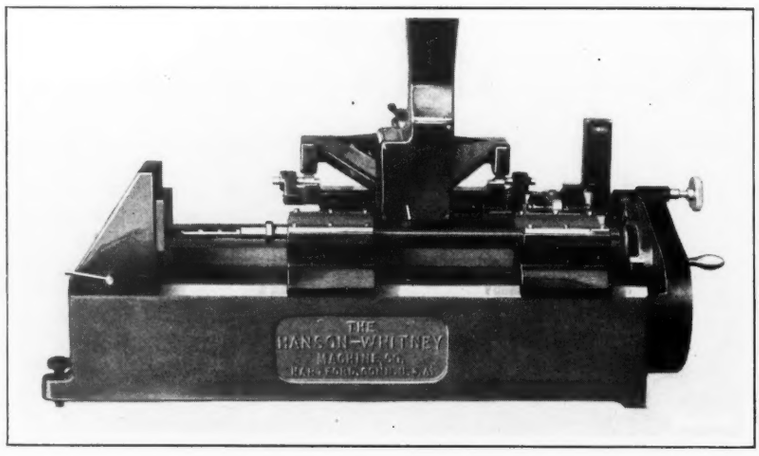


Fig. 3. Testing Lead on Long Screws

Different Applications of the Measuring Machine

The illustrations show different applications of the measuring machine. In Fig. 1 a screw is shown held between centers. An enlarged view of the same application is shown in Fig. 2 with a tap instead of a screw between centers. Fig. 3 shows a long screw laid in V-blocks, while Fig. 4 shows how round pieces are measured by being placed against a square block at one side, and touched by the end of a measuring rod held in the indicator point, on the other side. Fig. 5 shows how length gages may be measured in a similar manner.

The arm supporting the measuring point indicator, which is mounted on scale edges, is counterbalanced by a spring, so that in its normal position the measuring point is held out of contact with the object being measured, as shown in Fig. 1. When a measurement is taken, this arm is swiveled or rocked forward, as indicated in Fig. 2.

The precision lead-screw is protected by being placed under a ledge of the bed. The nut with which it engages contains a plain guide portion resting against the top of the Acme thread with which it is provided. This keeps the nut central with the screw at all times. The handwheel is so mounted that no weight rests on the screw. The capacity of the machine is for 12-inch measurements, but long screws can be measured by resting them in vees and moving them along the bed so that measurements of the lead can be taken at different portions of the screws.

WORK OF STANDARDS BUREAU

In the annual report of the Bureau of Standards submitted by its director, Dr. George K. Burgess, to the Secretary of Commerce, Herbert Hoover, the work of the bureau during the past year is completely reviewed. It is pointed out that 135,852 tests were conducted by all divisions of the bureau, most of the tests having been executed for other branches of the government. A great deal of testing, however, has been done for commercial firms and individuals, and since the founding of the bureau twenty-three years ago, 40,000 test folders covering over 600,000 such tests, for which a charge is made, have been issued by the Bureau of Standards. In some cases, tests for commercial firms have had to be refused because the demand exceeds the facilities available for doing this work. The report points out that it would be very desirable for the bureau to be able to carry out all tests required and paid for by manufacturers and individuals, because in this way the most effective assistance could be rendered to American industries.

Incidentally, the report mentions that at the present time over 85 per cent of the scientific instruments used in the United States are manufactured in this country. The development of this instrument industry has placed an additional burden on the Bureau of Standards, because many of these devices are sent to the bureau for final testing. The lack of adequate facilities has greatly handicapped the bureau in serving all American manufacturers in this field, and prevented it from doing all that it could do in developing and testing instruments of American manufacture. In some cases American manufacturers have been compelled to send their instruments to Europe or Canada for testing.

This condition could be remedied by an appropriation by Congress for further developing the service of the Bureau of Standards. Considering the total expenditures of the government, the appropriations intended to aid industry and commerce, which, in addition to agricultural pursuits, are the backbone of our national life, are very meager.

* * *

A journey of a thousand miles begins with one step.—*Chinese Proverb*

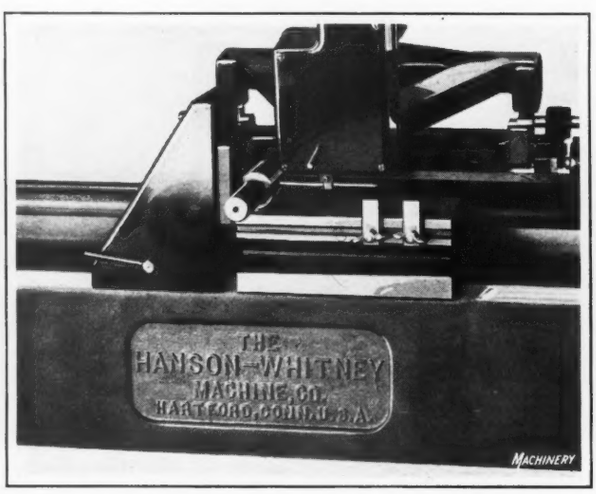


Fig. 4. Machine arranged for measuring Round Work

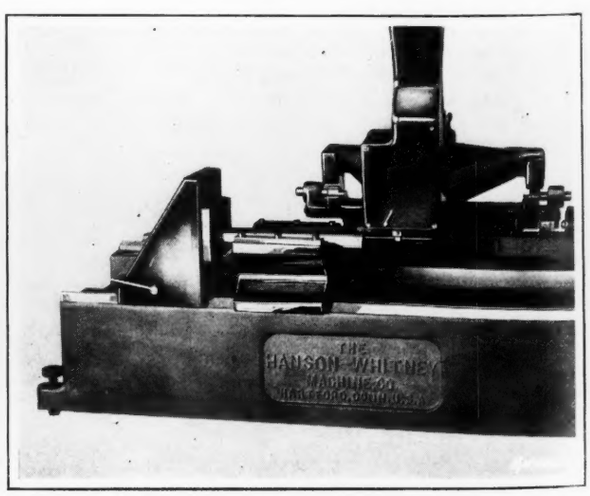


Fig. 5. Method of measuring Length Gages

CORRUGATING OVEN SHEETS

By P. J. SCHNEIDER

Several novel features are incorporated in equipment recently designed and built by the American Tool & Mfg. Co., Urbana, Ohio, for corrugating and performing other operations on oven linings. These linings are made from sheet iron 0.025 inch thick, which is first sheared to a width of 14 inches and then cut up into lengths of 20½ inches. In the corrugating process, the length is reduced to 11½ inches, but the width remains as before. At *A* in Fig. 2 is shown a sheet prior to corrugating, and at *B*, a corrugated sheet. When the sheets are assembled in the ovens, the corrugations serve as supports for racks.

The sheet is taken to the machine shown in Figs. 2 and 3 which is employed to roll the corrugations on it and which comprises the most interesting part of the equipment. In Fig. 3 the guards and feeding guides have been removed to show the construction clearly. It will be seen that there are two rolls *C* and *D*, each of which has thirteen teeth running the entire length of the rolls for crimping or corrugating the sheets. These teeth do not extend around the entire rolls, part of the upper roll being left smooth at the same radius as the top of the corrugating teeth, while the corresponding surface of the lower roll is also left smooth but at a radius equal to that of the root of the teeth minus the thickness of the stock.

On the lower roll there are two stop-pins *E*, which guide the sheet until it is gripped by the rolls. These pins are so arranged that they are pressed down into the lower roll as they are rotated in contact with the upper one. At the rear of the machine the sheet is fed on a horizontal shelf that prevents it from continuing around either roll. There is an adjustment by means of which the distance between the solid portions of the two rolls may be maintained 0.002 inch less than the thickness of the stock so as to produce a pressure that will insure a uniform location of the corrugations from the front end of the sheet. Feeding of the sheet into the rolls is facilitated by the guides on each side, as shown in Fig. 2. Owing to the length of the corrugations a comparatively large amount of power is required for the operation of the machine, and this fact accounts for the number of gears in the drive to the rolls. With this compound gearing one horsepower is ample to operate the machine. The rolls run at 20 revolutions per minute with a speed of 300 revolutions per minute of the lineshaft.

From the crimping machine the sheet is taken to a power press equipped with the die illustrated in Fig. 1, which trims the ends to length and bends them at right angles to the remainder of the sheet for a height of about ½ inch. This die also finish-forms the corrugations, the crimping operation just explained leaving the corrugations about 3/64 inch short. The extra power press step for finish-forming the corrugations sets them permanently. There is no squeezing action on the sides of the corrugations, and thus no ejector is required with the die. On the downward stroke of the punch, the sheet is firmly gripped between the spring-actuated pads *F* of the punch and surfaces *G* of the die, and sheared to length as the outer edges of knives *H* enter corresponding openings in the die member. The ends of the sheet are bent up when the inner dull edges of the knives enter the die.

The final operation on the sheet is conducted in a power press equipped with the die set shown in Fig. 4, and con-

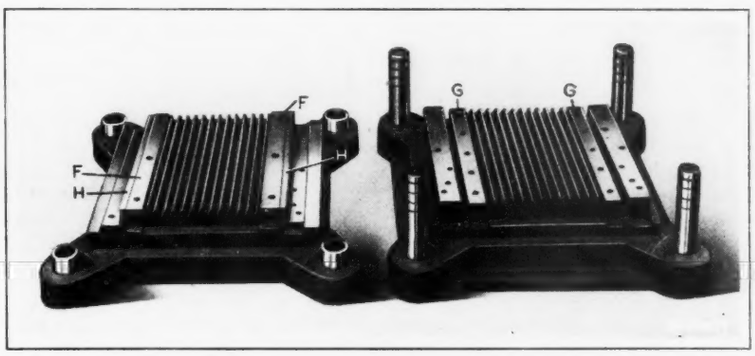


Fig. 1. Die Set for trimming the Sheets to Length and turning up the Edges, and for finish-forming the Corrugations

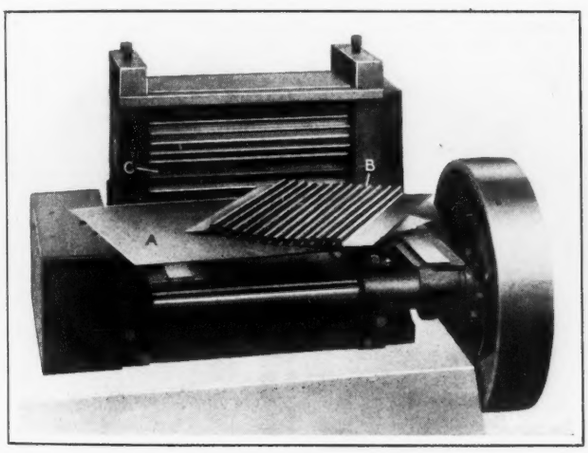


Fig. 2. Machine employed for producing Corrugations on Oven Linings made from Sheet Iron

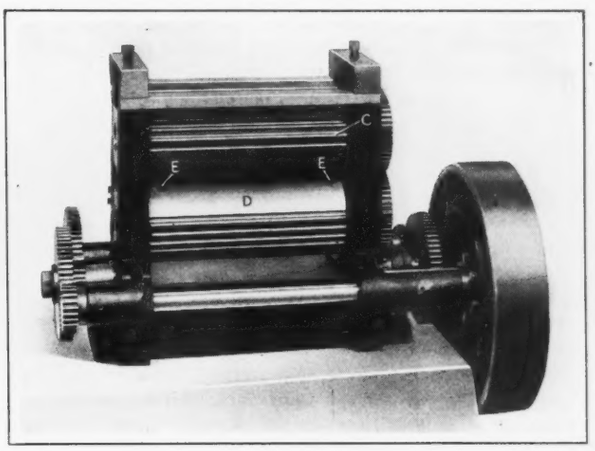


Fig. 3. Machine with Feeding Guides and Covers removed to show Crimping Rolls and Gearing

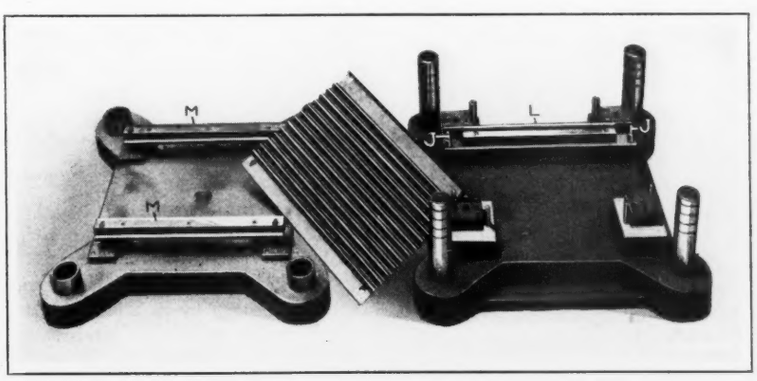


Fig. 4. Die Set for producing a Slot at each Corner of the Sheet

sists of slotting a hole at each of the four corners of the sheet. The sheet is located sidewise in the die by means of four pins *J*, one at each corner, while the long stop *L* is entered into one of the corrugations to hold the sheet lengthwise. On the downward descent of the ram, strips *M* on the punch hold the sheet firmly during the piercing operation, and on the upward stroke they force the work off the punches.

* * *

KEYWAYS IN MILLING CUTTERS

By CARL J. OXFORD
Chief Engineer, National Twist Drill & Tool Co., Detroit, Mich.

The editorial "Larger Keyways in Milling Cutters" in October MACHINERY, on page 102, is both timely and pertinent, inasmuch as a committee of milling cutter manufacturers is now considering the adoption of new standards. Our present series of standards for keyways in milling cutters were established in the days when high-speed production was an unknown and undreamed of thing. In late years we have seen the development of the high-powered, heavy-duty milling machine. We have also seen the practically universal adoption of high-speed steel for milling cutters. These two factors have made possible the use of feeds and speeds that some years ago would have seemed impractical, if not impossible.

As a result of these heavy feeds and high speeds, much greater strains have been imposed on both arbors and keys, often resulting in the failure of one or both. In many cases it is not possible to utilize either milling machines or milling cutters to their full capacity, because it is certain to result in shearing the driving keys in the cutters. How many times have we seen this happen on high-production jobs? If the machine has a power feed, as is usually the case, the cutter will invariably break, and frequently the arbor is sprung so badly that it is rendered useless as well. This happens because the machine keeps on feeding the work against the cutter after the latter has ceased to rotate. Production men can undoubtedly cite numerous instances where even worse things have happened, such as the stripping of feed-screw nuts or the breakage of other parts of the feed mechanism.

In view of the simplicity of the remedy, it is deplorable that such conditions should be permitted to exist. That they are still existing is perhaps partly due to the fact that milling machine and milling cutter manufacturers have not kept close enough to actual production conditions, and partly to the human tendency to oppose innovations. That there should be an immediate increase in the size of keyways in milling cutters seems almost beyond argument. The amount of increase, however, is worthy of careful consideration.

If our present sizes of keys and keyways were adequate when light milling machines and carbon steel milling cutters were used, and when milling was done at one-half or one-fourth the present feeds and speeds, then it seems reasonable that keyway proportions should be correspondingly increased. In other words the cross-section of the key should be made large enough to withstand the greater stresses imposed. One keyway of larger size seems preferable to two smaller ones. While the latter is theoretically correct, it is usually found in practice that the driving is all done by one key due to inaccuracies and imperfect fits.

Some consideration should also be given to the not improbable prediction that a few years hence we will be removing metal by milling much more rapidly than we do at present. Some of our up-to-date production engineers have awakened to the decided advantages of larger arbors and keyways, and have begun to specify accordingly. In one recent case a gang of straddle milling cutters 7½ inches in diameter was made up with a 3¼-inch arbor hole and a ½- by ¼-inch keyway. Other manufacturers are continuing to use cutters with the conventional 1¼ inch or 1½ inch arbor hole and corresponding 3/16- by 3/32-inch or ¼- by ⅛-inch keyway on identical operations and with the same diameter cutters. The life of the cutters having the larger arbor holes and keyways is undoubtedly more than double that of the others due to the entire absence of chatter, and they produce a smoother cut and materially contribute to a longer life of the milling machine.

The committee considering the question of sizes of keyways in milling cutters would do a service to the mechanical industries, if they would recommend not only larger keyways but larger arbor holes as well. The rigidity of a round bar, such as an arbor, increases with the fourth power of the diameter. Reduced to concrete figures, this means that a 1 3/16-inch diameter arbor has approximately twice the rigidity of a 1-inch arbor. Similarly, a 2-inch arbor is sixteen times as rigid as a 1-inch arbor, a 3-inch, eighty-one times, and a 4-inch, two hundred fifty-six times.

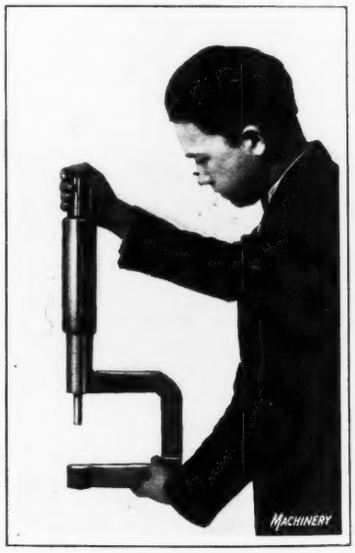
The users of milling cutters can do much toward increased efficiency if they will present their views and otherwise aid the manufacturers who are now endeavoring to establish new standards that shall be in line with present and future requirements.

* * *

MICROMETER FOR APPRENTICE INSTRUCTION

By HARVEY MEAD

The micrometer shown in the accompanying illustration has been used with great success in teaching boys in the shop how to make accurate measurements. The spaces between the graduations are made ten times as great as those of the ordinary micrometer, so that they can be easily read or pointed out to the class. The micrometer is constructed principally of wood in order to secure lightness, but the design is worked out along the same lines as a regular micrometer.



Micrometer used for instructing Apprentices

The thimble and barrel are both made of wood. The screw is of steel, ¾ inch in diameter, and has a 4-pitch double thread. This gives the spindle a movement of 0.250 inch for each complete revolution of the thimble. The maximum indicated opening between the anvil and the contact point of the spindle is 0.500 inch. The thimble graduations were made in a milling machine, and those on the barrel by screwing the thimble down to the zero line and then scribing a line at the end of the thimble, after turning it back one complete revolution. The nut in which the spindle turns was made by casting babbitt around the screw. This was done by placing the screw in a piece of 1-inch pipe, about 1½ inches long, and then pouring the molten babbitt around the screw. The short piece of pipe served as a grip for the wrench so that the nut could be started or turned on the screw. The piece of pipe was removed from the babbitt nut by splitting it with a hacksaw.

* * *

The use of safety razors appears to be increasing, according to the report of a large manufacturer. During 1923 the sales from this plant alone were 7,798,781 razor sets and 29,061,634 dozen extra blades, as compared with 3,420,895 sets and 24,082,970 dozen extra blades in 1922.

Letters on Practical Subjects

MACHINING A GRINDING WHEEL HEAD

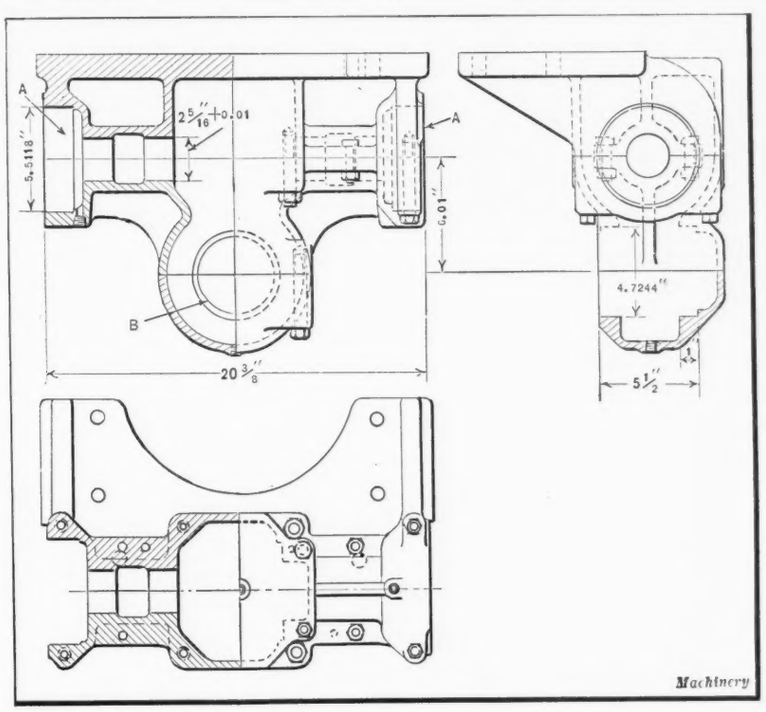
One of the most interesting jobs the writer has seen done in an engine lathe was the boring and facing of a spindle head like the one illustrated. This head is used for holding carborundum wheels employed in sawing marble slabs. The casting was set up on a Davis & Egan 18-inch engine lathe, and was supported on parallels of the right height to bring it in position for boring and facing the lower bearing indicated at *A*. A boring-bar was placed between the lathe centers, and the work lined up with the tool in the boring-bar. The head was then strapped down ready for machining.

The ends of the bearing were machined to bring their faces 20⅜ inches apart. Next the 2 5/16-inch holes were rough-bored at each end. The 5.5118-inch holes were also machined, and the shoulders of these holes squared out. Finishing cuts were then taken over the surfaces that had already received a roughing cut. Next the casting was set up for machining the bearing *B*. It will be noted that the bore of this bearing is at right angles to the holes previously machined. For this operation it was necessary to remove the lower half of the casting in order to bring the hole *B* into line with the machine spindle. After setting up the casting on the lathe carriage, a test bar was placed between the centers of the lathe. A parallel was then placed across the lathe ways, and a vernier height gage used to determine the height from the parallel to the center of the test bar.

The test bar was then removed and the head raised with thin steel shims until center lines scribed at a height of 6.01 inches at each end of bearing *B* were in line with the center of the spindle, as determined by the test bar and height gage. The top bearing was next squared up with the bottom one as described in the following: First a parallel was placed against one side of each lower bearing. Then a straightedge was clamped to the spider of the lathe, and by turning the spindle and taking measurements on each side of the parallels, it was possible to determine when the work was properly squared up. A special boring-bar with a tapered shank which fitted the lathe spindle was used to hold the offset boring tool. The offset tool was required in this case, as the hole to be bored did not extend completely through the casting.

After rough-facing the end of the bearing, the 4.7244-inch hole was bored, and the shoulder of the hole squared up to conform to the 5½-inch dimension. When the roughing cuts were completed, the surfaces were finished by machining in the same order as when being roughed.

Rutland, Vt. HARRY D. RICE



Grinding Wheel Head which was bored and faced in a Lathe

CUTTING WORM-GEARS WITH AN IMPROVISED HOB

In a certain shop in which the writer was employed, there was an old freight elevator operated by a worm and worm-gear. The worm had a single thread, a circular pitch of 1¾ inches, and an outside diameter of 8 inches. The pitch diameter of the worm-gear was about 33 inches. Both the worm and gear were cast iron. The worm had the thread cut in a lathe, but the gear had cast teeth. The life of the gears had been four or five years, but a change in the quality of the castings obtainable reduced the life to about six months.

In order to eliminate the necessity for making frequent renewals, plans were made to replace the old worm-gear with one having cut teeth. As the price quoted on cut gears was considered too high, it was decided to

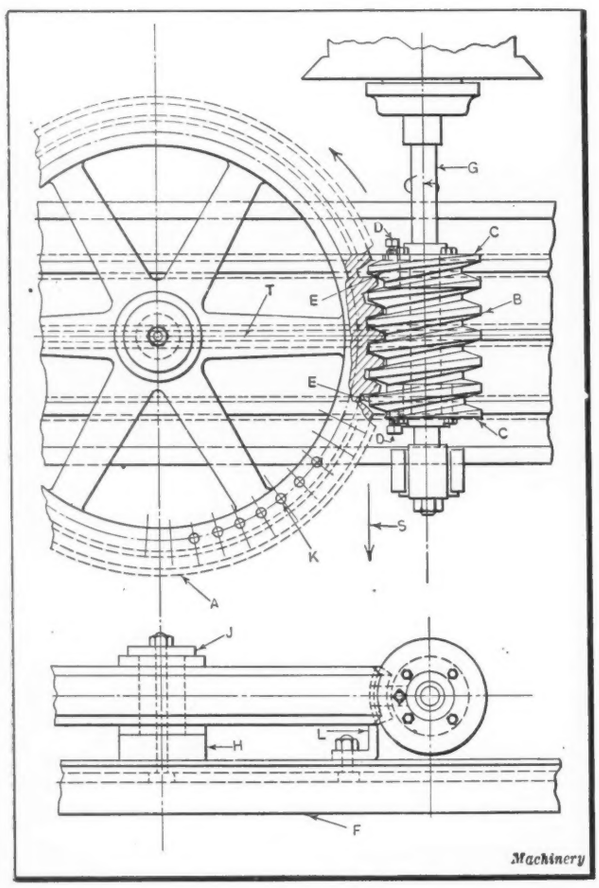


Fig. 1. Set-up used in hobbing Worm-gear with Improvised Hob

obtain a casting for the worm-wheel and cut the teeth in the shop. An old style No. 12 B & S plain milling machine and a 36- by 36-inch planer were the only available tools for cutting a worm-gear of the required size. A pattern for a grooved friction pulley was found which could be used to obtain a casting for the gear. The casting made from this pattern was bored and turned, and the face formed to the proper radius.

The worm-gear blank was gashed on the planer, an indexing device made up especially for the job being used, as no index-centers of sufficient capacity were available. The rim of the worm-wheel blank was spaced off with dividers to give as many equal spaces as there were tooth spaces in the worm-wheel. Then a ¾-inch hole was drilled 1 inch deep at each of these spaces, as indicated at *K*, Fig. 1. The cast-iron stud *H*, turned to a close running fit in the bore of the worm-gear blank, was used in mounting the blank on a large angle-plate, which was bolted to the planer platen in the same manner as indicated in Fig. 1. A ¾-inch hole was drilled and reamed in the angle-plate to line up with the index-holes in the worm-gear rim, and a short piece of cold-rolled steel made to serve as an index-pin. The gear was gashed with a tool having the same shape as the profile of a tooth space in the finished worm-gear. The angle-plate was, of course, set to correspond with the helix angle of the worm. The gashes were made deep enough to give the tooth space the correct form at the edge or sides of the blank, leaving the remainder to be hobbed out in the succeeding operation.

The worm, shown in Fig. 2 was made with two hubs turned to fit the collars *C*. Each of these collars was secured to the worm by four cap-screws, and the whole assembly turned and threaded as though it were one piece. A hole was then drilled in the center of the thread in each collar to receive the tools *E*. These tools were held in place by set-screws *D*, and were made the same shape as the worm thread and set in the collars *C* with their ends projecting about 1/32 inch beyond the top of the worm thread. Sufficient chip clearance was provided by the space formed by slabbing off the cutters so that their cutting faces would be on the center line.

Having made the worm and worm-gear blank as described, the next operation was the actual hobbing of the worm-gear. The gashed worm-gear blank was mounted on the stud *H*, Fig. 1, which was secured to the milling machine table *F*, the support *L* being placed under the rim of the blank. Worm *B*, with the two tool-holding collars *C* secured to it, was mounted on the milling machine arbor *G*, as shown. The height of the table was adjusted to bring the center of the worm to the same height as the center of the face of the worm-gear blank, and the table fed to the right until the thread of worm *B* was in mesh with the gashed worm-wheel blank.

The table was next fed outward in the direction of arrow *S* until the center of the cutter in the outer collar coincided with the line *T* which passes through the center of the worm gear and is at right angles with the axis of the worm. Then the table was fed to the right until the tool took a cut having a depth equal to the amount which the cutter projected beyond the top of the worm thread or 1/32 inch. The cross-feed was next used to continue the feed of the table in the direction indicated by the arrow *S* until the tool in the inner collar *C* reached the central position on line *T*. Then the table was again fed to the right about 1/32 inch, and the hand cross-feed employed to move it in the direction opposite to that indicated by arrow *S* until it was returned to the original starting point. Next the table was again fed to the right 1/32 inch, and the cross-feeding operations repeated until the tooth spaces were cut to the required depth.

The effect obtained by feeding the worm-gear across the worm provided with the two cutters *E* was the same as would have been obtained by using a hob in the regular manner. The two collars *C* with the cutters in place were removed from the worm and put away with the stud *H* so that they could be used whenever it became necessary to replace the worm-wheel. The time required for hobbing the gear was about 12 hours, and the total cost of the gear and worm was a little less than one-half the price quoted by the dealers. Although the worm-gear made as described has been in use for six or seven years, it is in good condition and apparently capable of giving satisfactory service for some time to come.

Worcester, Mass. W. R. STULTS

MAKING A METRIC TAP

During the war, a manufacturer in the Middle West engaged in the production of shrapnel fuses found that his production would be stopped unless he could obtain a special metric machine tap. This tap was about 3/16 inch in diameter and had a pitch of 0.75 millimeter (33.87 threads per inch), and an overall length of 6 inches, with the threaded portion approximately 1¼ inches long.

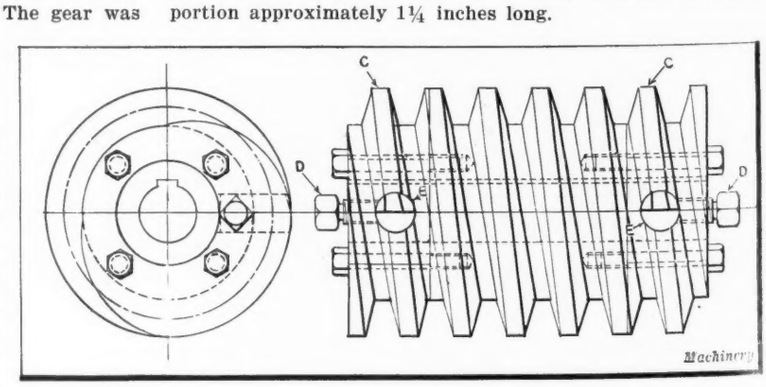
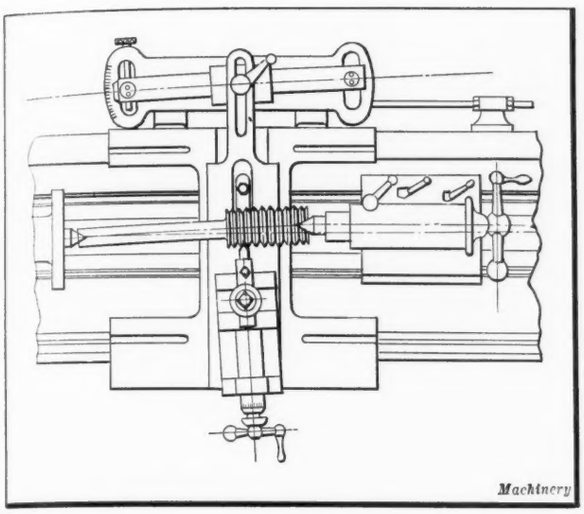


Fig. 2. Worm with Cutter-holding Collars secured to Each End



Lathe with Tailstock offset and Taper Attachment set for cutting Metric Thread

As the eastern manufacturer of the taps could not supply replacements at once, the manufacturer of the shrapnel fuses tried to find a local tool shop which would produce a few taps. All the toolmakers approached on this subject replied that it would require the making of special change-gears and a delay of about one day. The manufacturer accordingly gave a small tool shop an order to make up several of the taps. A machinist operating a 9-inch engine lathe was given the steel from which to turn the taps, and was told that special change-gears would be made for the threading operation. While an attempt was being made to figure out the number of teeth required in the special gears, the machinist who was turning out the blank taps inquired if it were possible to obtain one of the special taps, remarking that if he were provided with one, he could produce good duplicate taps in less than two hours without making any special equipment.

On being given the last special tap available at the fuse plant, the machinist proceeded to center up two of the blank taps, so that the distance between the centers would be exactly the same as the distance between the centers of the sample tap. The lathe was then adjusted to cut thirty-four threads per inch, which came within the range of the threads provided by the quick change-gear box. Next the taper attachment was set to an angle of 4 degrees 57 minutes, which had been previously calculated, the tap blank placed between the lathe centers, and the tailstock set over until an indicator showed the axis of the tap to be parallel with the bar of the taper attachment. A sample tap with the driver attached was then put on centers.

The threading tool was then set so that it could be fed into the full depth at the front of the tap, the dial reading on the compound rest being noted when the tool reached the bottom of the thread. The tool was next withdrawn and the belt pulled by hand until the carriage had been advanced about one inch, at which point the tool was again advanced or brought into contact with the thread groove of the tap. It was found necessary to make a slight adjustment of the tailstock and the taper attachment before the tool would line up properly at both ends of the tap. Thus, while the longitudinal travel of the carriage was the same as that used for cutting 34 threads per inch, the number actually cut was less than 34, due to the angular position of the work with relation to the lathe ways.

The threading tool was set normal to the axis of the tap. A driver with a narrow edge contacting with the pin on the driving plate was used in order to keep the turning speed of the work as uniform as possible. With this arrangement the periodic error in the lead resulting from the offset position of the tailstock was very slight. A new tap was produced in this manner in less than two hours, and five hours later thirty more fluted and relieved taps were ready for use.

Detroit, Mich. L. C. BLOMSTROM

APPLICATION OF BUTTON METHOD OF LOCATING WORK

When very accurate work is required, the writer generally employs buttons in setting up the job. After the overall measurements have been calculated, micrometer measuring instruments are used to locate the buttons on the work. The buttons are usually made from one-half-inch drill rod and are faced square on one side. If there is no objection to screw-holes in the work, the buttons are secured in place by means of machine screws, but if screw-holes are objectionable the buttons are secured by soldering.

The diagram Fig. 1 shows the method employed in locating test buttons when machining a surface to correspond with the arc of a circle having a given radius. In this case the work is to be machined to the outline indicated by arc *A*, the radius of which is *R*. In order to locate the buttons *E*, *F*, and *G* tangent to arc *A*, the writer employs a straightedge *H* and micrometers for setting the buttons to the dimensions *C* and *D* which must, of course, be calculated before proceeding with the set-up work.

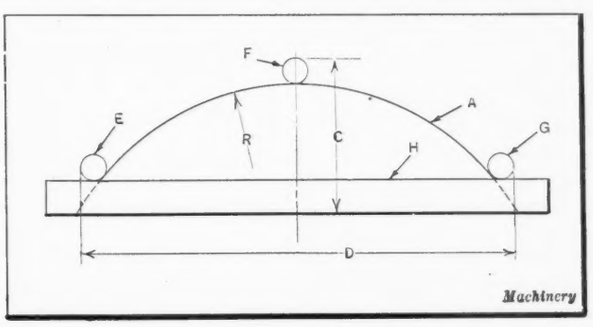


Fig. 1. Method of setting Buttons Tangent to Arc

The method of using buttons when planing two slots in a piece of cast iron so that their edges will form a given angle *x* is shown at *B*, Fig. 2. After calculating the distance between the buttons, they are set in their proper positions and held in place with clamps while being soldered to the work. With the buttons properly located, it is a simple matter to clamp the work to the planer bed in such a position that the line of travel of the tool across the work will be parallel with a tangent to either pair of buttons. The writer has found this method to be much more accurate than attempting to line up the work so that a scriber held in the toolpost of the machine will follow a line scribed on the work.

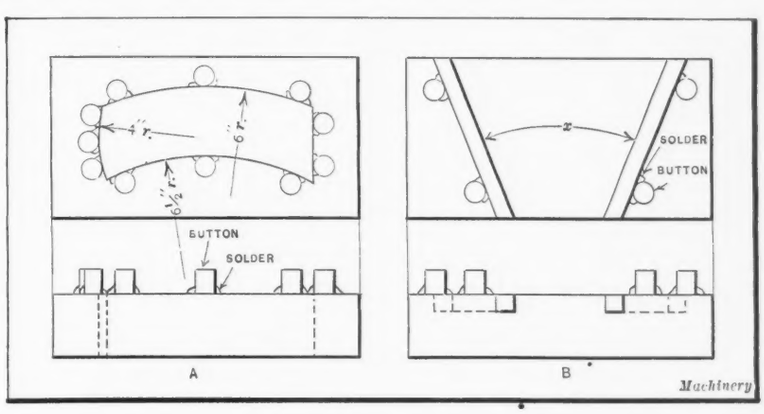


Fig. 2. Diagrams showing Methods of using Buttons in setting up Work

The view at *A* shows the method of locating the buttons when machining curved or irregular openings in dies. With the type of machine used in machining the die openings, it is easy to line up the work so that the path of the tool will be tangent to the peripheral surfaces of the buttons.

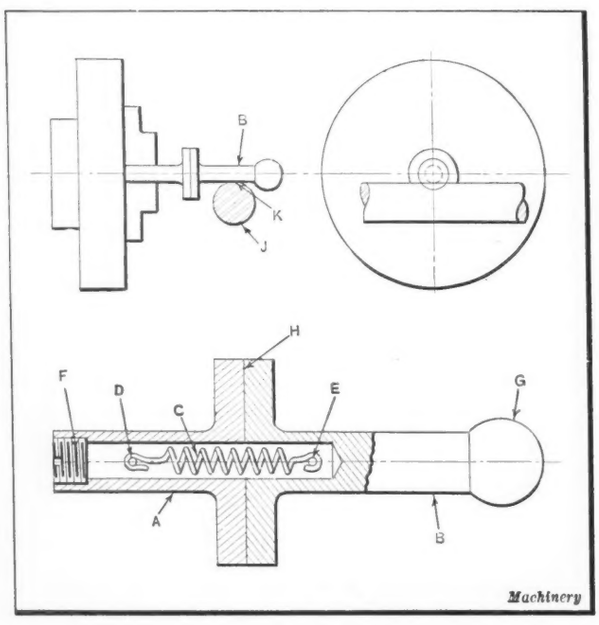
Philadelphia, Pa. CHARLES KUGLER

INDICATOR FOR MILLING MACHINE

One of the cleverest indicators the writer has ever seen is shown in the accompanying illustration. It was made principally for use on the milling machine, but can easily be adapted for use on other machines where it is desired to find the relation of a given surface to the center line of the machine spindle. The instrument is constructed as follows: The shank *A* and body *B* are both turned from tool steel, and the flange end of each is drilled to receive the spring *C*, which is fastened to the two parts by means of the pins *D* and *E*. The hole in the shank *A* is closed by the threaded plug *F*. The body *B* has a hardened steel ball *G* mounted at the outer end. The whole instrument is hardened and ground, and the faces at *H* are nicely lapped.

In use, the instrument is held in the milling machine chuck as shown in the upper view. The shaft *J* is held between the milling machine centers. Let it be assumed that a hole is to be drilled and bored through the exact center of this shaft. The instrument having been chucked as shown, the work is slowly brought up against it. Before the work is brought up against the tool, the body *B* will be running "out" or eccentric to the axis of the milling machine spindle, but as the work is slowly brought up against it, body *B* will true up. This action will be noted by the fact that as long as the body of the instrument is running out, there will be a streak of light showing between the work and the tool at *K*, and when the tool is running true, this will disappear. If, however, the work is brought up too far, the end of the instrument will appear to be moving from right to left as it is rotated when viewed from the tailstock end of the table.

Several trials may be required to bring the work to the exact height, after which it will only be necessary to add



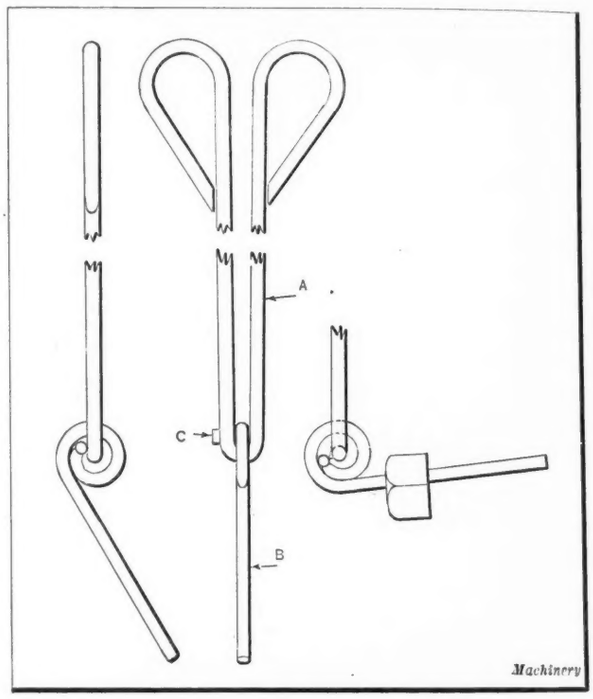
Indicator for centering Work on Milling Machine Table

half the diameter of the work to half the diameter of the instrument and move the milling machine table up this amount in order to bring the center of the work *J* up to the center of the machine spindle. The instrument is accurate to within 0.0005 inch. The movement or setting of the table, however, depends upon the individual machine. The instrument is used for locating flat work in the same manner except that the flat surface of the work makes contact with the ball *G* instead of the body *B*. The tool is extremely simple to make, is reliable, and its many applications make it a useful addition to any toolmaker's kit.

DONALD A. BAKER

HOOK FOR RECOVERING NUTS

A novel wire hook for recovering nuts that are accidentally dropped into inaccessible places during assembling operations is shown in the accompanying illustration. The advantage of this device over a simple piece of wire bent at



Hook for recovering Nuts from Inaccessible Places

one end, such as is often used in machine-building plants, is that the hook is a separate piece and can be manipulated to suit conditions. The construction of the device will be easily understood from the illustration. It is made from ⅛-inch wire, one piece *A*, being formed into a handle with loops for the fingers at one end, while the other end carries the hook *B*. The hook is coiled around the lower end of part *A* as shown, one end *C* of the coil being bent at right angles so that the hook is normally held at an angle as shown in the view at the left of the illustration.

Nuts that have been dropped in inaccessible places can, as a rule, be easily recovered with this device. The hook can be held in any position by squeezing the looped ends of the handle together; for instance, if a nut happens to be in a face down position, the end of the hook is inserted in the hole and the handle pushed down until the hook is in the position shown in the view at the extreme right-hand side of the illustration. While this is being done the nut will slide up on the hook. The loops at the end of the handle are then squeezed together so that the hook will be held in this position while the nut is being lifted out. The construction of the device and the method of using it are such that it can be passed through very narrow openings.

Rosemount, Montreal, Canada HARRY MOORE

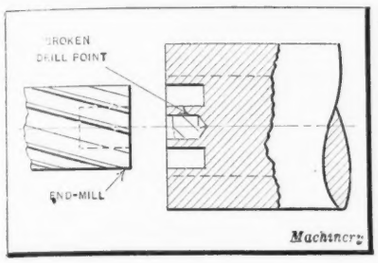
* * *

A thermo-electric accumulator furnace has been developed by a Swedish inventor which can be heated and adjusted accurately to any degree up to 1300 degrees C. On account of these features this furnace can be used to advantage for heating metals, especially iron and steel for manufacturing processes.

Shop and Drafting-room Kinks

REMOVING BROKEN CENTER DRILL POINTS

Anyone who has used a center drill has doubtless found that it may be broken easily and the small drill point left in the work. Usually it is not an easy matter to remove this point. The following method, however, has been used by the writer with success. An end-mill with an outside diameter slightly smaller than the finished hole and a recess that is larger than the broken drill point is used in the manner indicated in the accompanying illustration. The end-mill is carefully fed into the work until the stock surrounding the point is cut away. A few taps with a hammer on a center-punch will then loosen the broken drill point so that it will drop out.



Method of removing a Broken Drill Point

Fitchburg, Mass. A. BERG

IMPROVING THE STEADYREST

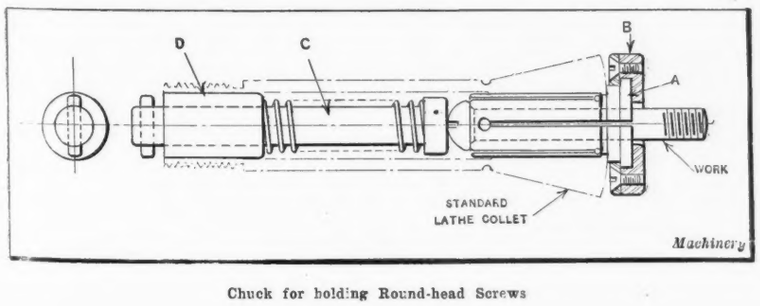
The steadyrest is a lathe attachment that must be used frequently in the regular run of work, but is considered by many workmen as a sort of necessary evil to be employed only when the work cannot be handled in any other way. A slight change in the standard type of steadyrest, however, will make the use of it a real pleasure. The change is made by replacing the regular square-head set-screws used to adjust the jaws with knurled-head screws which can be easily turned by the fingers alone. For the ordinary run of light work, the knurled head should be about 1 inch in diameter for a ½-inch screw. This head can be made from a separate piece of stock and riveted or welded to the necked down end of the screw. The end of the screw that bears on the jaw should be necked or tapered to give a small contact surface, permitting the screw to be easily turned by the fingers.

Boise, Idaho GEORGE X. JOHNSTON

QUICK-ACTING CHUCK FOR ROUND-HEAD SCREWS

The device shown in the accompanying illustration was made for use in cutting off or shortening several thousand 5/16- by 2 3/8-inch round-head screws. With this type of chuck, the lathe spindle can be run continuously and no wrench is needed to release the work. A standard lathe collet is used to hold the special chucking device. The hole in the standard collet must, of course, be slightly larger than the head of the screw. The sleeve *A* is slotted to permit it to contract and grip the work when subjected to the clamping pressure of the collet.

The sleeve has a freely revolving head *B* which allows the operator to safely reload the device with a new piece of work without stopping the spindle. The plunger *C* is a sliding fit in the bushing *D*, which is pressed into the rear end of the collet. When clamping the work in place, the operator holds sleeve *A* against the end of the collet, and the plunger *C* then forces the inside of the screw head against the inner end of the sleeve, thus insuring exact positioning of the work so that all the screws will be cut off to the same length.



Chuck for holding Round-head Screws

Eastwood, N. Y. ELMER C. COOLEY

DEVICE FOR DRAWING LETTERING GUIDE LINES

A device that will enable the draftsman to draw accurate guide lines quickly is shown in the accompanying illustration. This may be made from brass or celluloid about 1/16 inch thick. The steps should be 1/32 and 1/16 inch high, respectively, for letters 3/32 inch high. A step 1/4 inch high is also provided for use when lettering titles with capital letters. The angle of 60 degrees at the left-hand side of the device is used for drawing the short lines that govern the slant of the letters on horizontal lines. The angle of 30 degrees at the right-hand side is used when the lines are in a vertical position, as indicated at *B*. In using the device, the point of the pencil is placed on the proper step and the device and pencil are slid along the T-square or along the edge of the triangle.

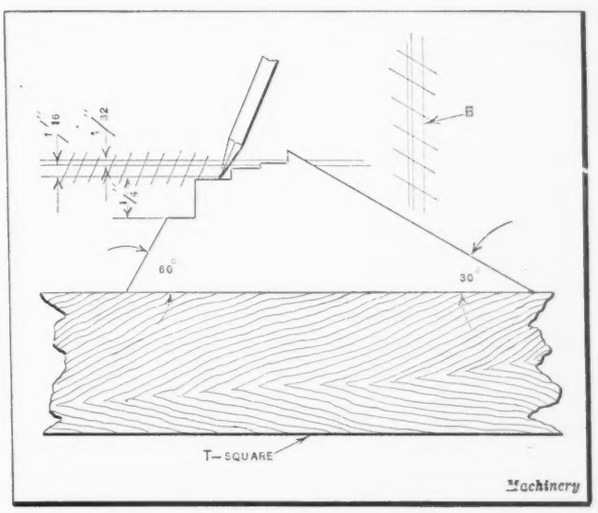


Diagram illustrating Method of drawing Lettering Guide Lines

EMMONS W. CRAWFORD
Peterborough, Ontario, Canada

* * *

According to an item published in *Aviation*, a German manufacturer of airplanes has brought out a small light-weight plane carrying an 18-horsepower engine. The plane is of the cantilever-monoplane type with the wing built in two sections. The machine is said to have proved to be very safe and easy to operate.

THE BRITISH MACHINE TOOL INDUSTRY

From MACHINERY'S Special Correspondent

London, December 13

Business conditions during the past month have shown a strengthening of that feeling of security that generally prevailed after the recent election. All the important manufacturing centers show increased confidence in the improving business prospects, as is evidenced by the greater freedom with which equipment is being renewed and extended. The machine tool industry is naturally reflecting the general improvement, and there are very few sections that do not show an activity comparing more than favorably with any period of the last three years. The principal demand is for standard machines of improved manufacturing type, whereas orders for special machines, which have up to now formed the nucleus of the work that has kept many machine tool shops going, are relatively in much smaller demand.

Inquiries at present are largely for milling machines, heavy-duty drilling machines, turret lathes and screw machines, and grinders. Substantial orders have been placed for each of these types, and in many instances there are immediate prospects of heavier repeat orders. Some of these orders can be traced to the Machine Tool Exhibition held at Olympia, one large automobile manufacturer having ordered sixteen machines of a new design shown at that exhibition.

Machine tool makers in the Midlands, in particular, are experiencing a decided expansion of business. The general trade revival has stimulated the renovation of manufacturing plants, almost every type of which is represented in the Midlands area, and local machine tool makers are receiving many inquiries. Automobile manufacturers, electrical engineering firms, and textile machine makers are among those contemplating additions to plant and equipment.

Leading Yorkshire machine tool manufacturers are, for the most part, well employed, and it is of interest to note that the firm of John Lund, of Keighley, has its shops busy with machine tools for the textile machinery trades. Vertical surface grinding machines made by this firm are receiving a good deal of attention, and a machine of this type now being made has a bed 44 feet long and will grind work up to 25 feet in length. The same makers are building a special shaping machine with ten tool-boxes, which operates on three sides of the work at the same time.

Makers of 13-inch swing and larger lathes in this locality are only moderately employed, but there is a demand for surfacing and boring lathes, planers, automatic spur gear cutting machines, bevel gear planers, and radial drilling machines up to 5 feet in size.

In the Manchester area, reports show that fair progress is being maintained; new work is not plentiful, but an increasing number of inquiries materialize into orders. The drafting-rooms of the more important machine tool firms in the district are busy with estimates, and there is generally a distinctly hopeful outlook. Makers of horizontal boring machines and turning and boring mills appear to have plenty of work in hand, but there seems to be a temporary lull in the demand for grinding machines.

In the Glasgow area there is evidence of a return to better times. However, few important firms are working to capacity, and new machine tool business in this area still appears to be overshadowed by the second-hand machine tool menace.

General engineering conditions have also improved.

Overseas Trade in Machine Tools

The improvement in machine tool exports noted in September was more than maintained during October. In September, the value of exports reached £120,250 for 1048 tons; during October the corresponding figures were £122,500 and 1087 tons, the value per ton being about £113. Imports of machine tools during October rose in both value and tonnage, £32,700 for 187 tons in September rising to £44,336 for 247 tons in October. The value per ton of October imports reached the high figure of £179. The export of small tools and milling cutters is growing in value and exceeds the value of the imported machine tools.

PRIZE WINNERS

Fifteen prizes were offered by MACHINERY in the November number for the best articles to be submitted on

The Most Interesting Device or Method for Gaging, Measuring, or Inspection that I Have Ever Seen

A great many articles illustrating and describing devices and methods of unusual interest were entered in this prize competition from every industrial section of the United States and from several foreign countries. From the large number submitted, the fifteen prize-winning articles have been carefully selected, the selection being based upon such essential factors as originality and practicability of the device or method, and the care evidenced in the preparation of the article and the illustrations. The prize-winning articles will be published in MACHINERY from time to time during the coming year.

The prize winners and prizes are as follows:

Two Prizes Consisting of MACHINERY'S Encyclopedia:

Frank H. Mayoh, 72 Westfield Road, Holyoke, Mass.

W. R. Graham, 327 Fifth St., Roselle, N. J.

Two Prizes Consisting of Ten Volumes Each of MACHINERY'S Mechanical Library:

Philip F. Shafran, 1745 Fiftieth St., Brooklyn, N. Y.

Charles F. Stein, 845 Harry Ave., Kenosha, Wis.

Four Prizes Consisting of Five Volumes Each of MACHINERY'S Mechanical Library:

C. M. Gottschau, 24 Maple St., Waterbury, Conn.

F. H. Rauh, 33 Littleton Ave., Newark, N. J.

Charles S. Muirhead, 18 Learmouth St., Falkirk, Sterlingshire, Scotland.

Harry Brook, 60 Bernice Ave., Woonsocket, R. I.

Seven Prizes Consisting of Three Volumes Each of MACHINERY'S Mechanical Library:

H. C. Ten Horn, Voorstadslaan 47, Nijmegen, Holland.

Rowland L. Hill, 520 S. Harrison St., Saginaw, W. S., Mich.

William C. Landis, Westinghouse Air Brake Co., Pittsburg, Pa.

Carl A. Wahlgren, Watchung Place, Bloomfield, N. J.

Edward M. Heiser, 5718 Portage Ave., Cleveland, Ohio.

Gus H. Froelich, 7454 Teasdale Ave., University, St. Louis, Mo.

Douglas P. Muirhead, 24 Kilmailing Road, Cathcart, Glasgow, Scotland.

The cooperation of so many of MACHINERY'S readers will make it possible to place on record, for the service of thousands of other readers, the useful ideas and suggestions contained in these articles.

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

Melling Crankshaft Turning Machines

TWO machines intended for use in the quantity production of crankshafts have recently been developed by the Walcott Lathe Co., and the Jackson Shaper Co., Jackson, Mich., closely affiliated concerns. The machine built by the Jackson Shaper Co. is for turning crankpins, provision being made for simultaneously turning all pins. The second machine finishes the periphery of all the crank cheeks at the same time. Both are named after the designer, H. W. Melling.

In machining crankpins, it is imperative that the diameter and length of each pin, the indexing of the pins relative to each other, and the throw of the cranks be accurate. In the machine shown in Fig. 1 these are all automatically controlled so that the operator is merely required to set up the forging and remove the work after it is finished. As a result he is able to handle two machines. The illustration shows one of the first machines built, which was provided with a belt drive, but it is now the intention to equip all machines with individual motor drive.

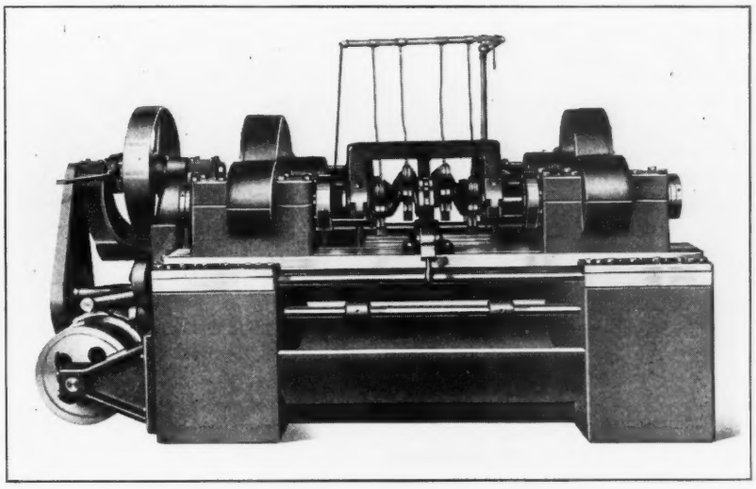


Fig. 1. Melling Automatic Crankpin Turning Machine

From the motor, power will be transmitted by a silent chain to a control shaft at the rear which carries as many eccentrics as there are throws on the crankshafts to be turned, and these eccentrics have the same throw as the cranks. The machine is of the "pattern reproducing" type, which means that each eccentric carries an arm, at the forward end of which is mounted a tool for turning a crankpin. There is an adjustment on the tool arms to provide for setting the machine to suit any diameter of crankpin. The crankshaft forging is set up in pot chucks mounted on the two opposed spindles, which are driven through direct gearing from the control shaft at the rear. Thus, the eccentrics on the control shaft and the work rotate in unison. In addition to being held by chucks, the work is also supported by steadyrests. On the job illustrated, only one rest is employed, because there is only one line bearing at the center of a four-cylinder crankshaft. However, if the machine were working on a six-cylinder crankshaft having two such line bearings, two steadyrests would be used.

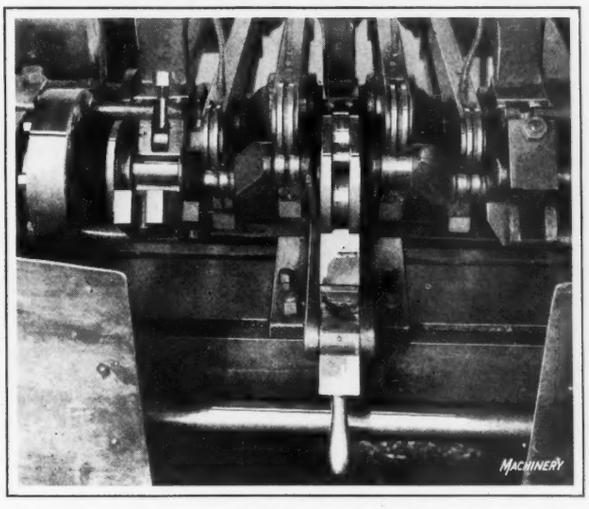


Fig. 2. Close-up View of the Work and Rollers attached to the Tool Arms

The tool mounted on the front end of each tool arm works at the rear of the crankpin, a supporting roller attached to the arm running on top of the pin, as shown in Fig. 2. When the rough forging is set up, this roller starts on the forged surface, and as it is set slightly more than 90 degrees from the point of the tool, it tends to carry the tool thrust and prevent the tool from backing away from the cut. Carrying the tool thrust in this way relieves the eccentrics of the load, and they are left unimpeded to perform their function of controlling the diameter, throw, and indexing of each crankpin. As each tool arm is pivoted on an eccentric, there would be a possibility of trouble in securing accurate longitudinal spacing of the crankpins unless special provision was made to hold each tool arm, near its outer end, against motion resulting from side thrust. This is accomplished by having a crankshaft that is a duplicate of the work, mounted behind the work and supported by a cradle. Each tool arm has a bearing on this auxiliary crankshaft to hold the arm against sidewise movement while it is free to float up and down.

The turning tools are of sufficient width to turn one-half the length of the crankpins as the work is fed to the tools. Then the work-table is moved longitudinally and fed a second time to the tools to complete the operation. Cams located at the left-hand end of the machine govern the table movements and also the vertical movements of the cradle in which the tool arms are supported. The pins of the four-cylinder crankshaft shown in the machine were finished in 1 minute and 35 seconds.

The Contour Turning Machine

The machine built for finishing the periphery of crankshaft cheeks follows the design of the camshaft turning machine built by the Walcott Lathe Co. for the last few years. It is also similar to the crankpin ma-

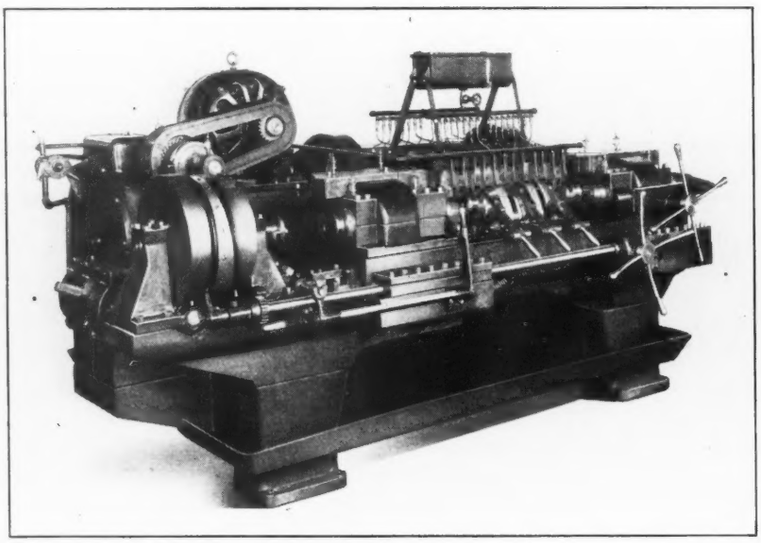


Fig. 3. Machine which simultaneously turns the Cheeks of All Cranks

chine in that it operates on the "pattern reproducing" principle and all cheeks of the shaft are machined in a single operation. This machine is illustrated in Fig. 3.

Each cheek periphery is turned by a single-point tool, controlled by a master cam of the same size and shape as the periphery. This cam runs in contact with a roller to move the cutter in and out in a horizontal plane. As the cam rotates in engagement with this roller, the point of contact rises and falls in relation to the horizontal center line and, therefore, in order for the tool to duplicate the form of the cam on the work, it is necessary for its point of contact with the work to rise and fall in a similar relationship to a horizontal line. This is accomplished by mounting the tool in a pivoted holder that is oscillated by another cam. This movement also keeps the angular relationship between the tool lip and work constant.

An individual motor drive is furnished on this machine from which power is transmitted through a silent chain and worm-gearing to a shaft at the back of the machine on which there are mounted as many cams for oscillating the tools as there are cheeks to be turned. For each of these cams there is a complete mechanism for oscillating the corresponding holder. From this camshaft power is transmitted by herringbone gears to a shaft on which are mounted the master cams for the tools, and thence by gearing to the opposed work-holding spindles.

In an operation, after a forging has been placed in the chucks carried by the spindles, quick-acting steadyrests are closed to engage the previously turned line bearings. Then the main driving clutch is engaged, after which the machine proceeds through an automatically controlled sequence of operations and requires no further attention until the work is finished. The work-heads are mounted on a table similar to the one on the crankpin turning machine, and the table has the same combination of transverse and longitudinal movements which are controlled by a similar arrangement of cams. However, cutting is accomplished by feeding the work past the tools, and roughing and finishing cuts are taken. Hence, the cam that governs the transverse movements of the table has two steps so that the work may first be fed to the tools for the roughing cut and later advanced further for the finishing cut. Before the table is returned to the starting point, it is backed away from the work to prevent scoring. An automatic trip throws out the main clutch at the end of the return movement.

AJAX CONTINUOUS-MOTION HEADING MACHINES

Continuous-motion machines of heavy design, intended principally for hot-heading rivets and bolts of various kinds, have recently been developed in four sizes by the Ajax Mfg. Co., Cleveland, Ohio. The rated capacity of these four sizes is for ¾-, 1-, 1¼-, and 1½-inch work, respectively. The heads of rivets and carriage and track bolts are formed without flash and do not require trimming, but in filling out the corners of square and hexagonal head machine bolts, a washer-shaped flash is formed around the bottom of the head, which may be trimmed off cold in a press. Special bolts and one-blow forgings, such as automobile rim bolts, king bolts, and valve tappets, can also be produced. Much of this work can be done at temperatures commonly termed "semi-hot," so as to reduce scaling. With the work "semi-hot," the machines are capable of producing parts up to three-fourth of the rated size, the rated size being based on stock heated to a temperature of from 1500 to 1800 degrees F.

The general arrangement of these heading machines has been improved over past designs by transferring the die-slide operating mechanism from the left- to the right-hand side. This makes it possible for the operator to feed the stock, observe the quality of bolts or rivets as they come through the discharge port, and adjust the stock gage, all from one position. With this arrangement, the left-hand side of the machine is clear, which facilitates setting up dies and tools and supervising the production. The header slide is of increased length, and operates in V-type ways that are roll-lubricated. There is a top suspension for the die slide, so that scale does not accumulate on its bearings. The front-side liner of this slide is adjustable for wear, to insure square shearing of the stock.

Hand or Automatic Feeds

Either a hand or an automatic feed is furnished. With a hand feed, rods heated for a distance of 4 or 5 feet are fed by the operator against a stock gage, the machine then shearing off a blank, heading, and ejecting it. With this feed the output ranges from 14,000 to 18,000 pieces per ten hours. With the automatic feed, mill-length rods are heated the entire length and started by the operator into rolls that feed them into the machine. A piece is produced at each revolution of the machine, the output varying from 30,000

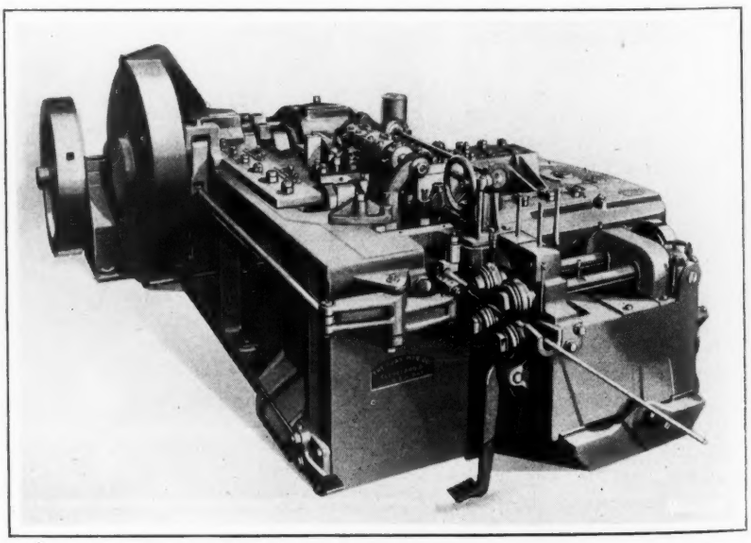


Fig. 1. Ajax Heavy-duty Continuous-motion Heading Machine

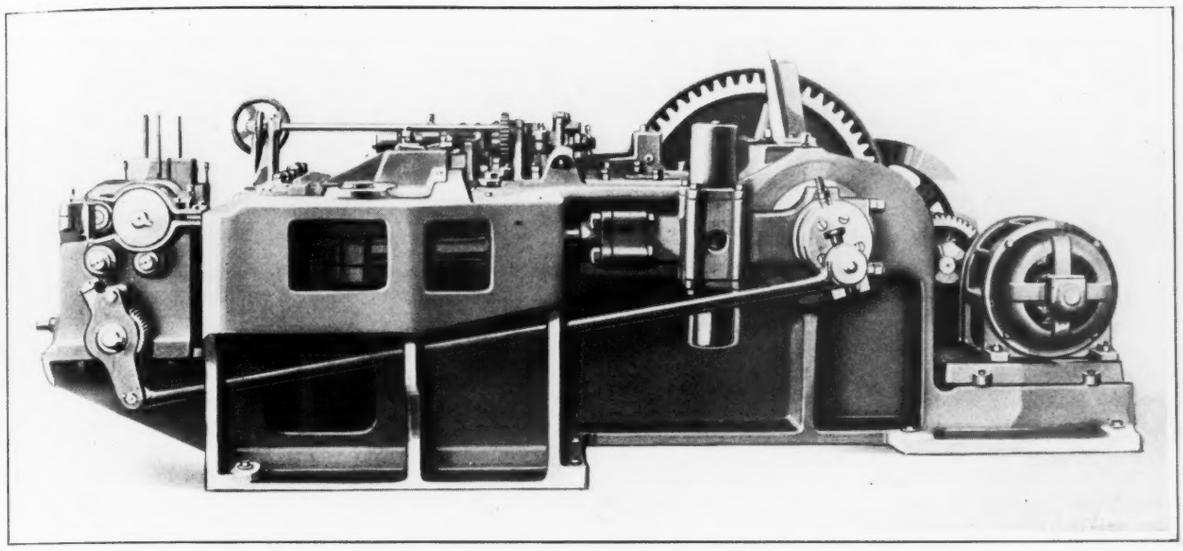


Fig. 2. Drive to the Automatic Roll-feed Mechanism of the Heading Machine

to 50,000 parts per ten hours, depending upon the length and size of the work.

The roll-feed mechanism is operated from an adjustable crankpin on the end of the crankshaft, as shown in Fig. 2. The eccentricity of this pin may be changed by means of an adjusting screw to make the rolls feed the correct amount of stock for a given length of bolt or rivet. The feed-rolls consist of rings, the circumference of which is grooved to suit the stock. They can easily be changed to accommodate different sizes of stock and adjusted for various shear center distances. Removable weights control the pressure on the rolls. In case a piece of work sticks, the feed can be stopped and locked out by depressing the foot-pedal. Finished pads on the front of the hand-feed machines make it possible to attach the automatic mechanism at any time. The feed-roll gears are completely enclosed in a housing which is adjustable to reduce the waste from cropped ends to a minimum.

The Heading Operation

Both hand- and automatic-feed machines operate on the same principles, so far as the heading mechanism is concerned. The heated bar is ported through a breast plate until it strikes the stock gage, which is so set that just enough of the bar projects to make the finished rivet. The moving die travels across the breast plate, shearing off the blank on the cutter, and gripping it against the stationary die. The header slide next moves forward, a cam on top swinging the stock gage out of the way, and the heading tool then heads the stock which projects from the dies, against the face of the dies. After this, the heading tool backs off and the dies open, allowing the headed piece to be knocked out of the dies by an ejector. Water from overhead pipes is directed on the dies and the heading tool to keep them cool and also to carry away the scale.

Either a belt or a motor drive can be supplied. On belt-driven machines the flywheel is mounted direct on the end of the crankshaft and a clutch countershaft is provided. The motor drive is through direct gearing, a safety friction clutch cushioning the motor from shocks and protecting both the machine and motor from damage should anything prevent a complete revolution of the crankshaft. An adjustable-speed motor makes it possible to operate a machine efficiently on both light short work where high speeds are permissible and heavy long work where reduced speeds are necessary. However, a constant-speed motor is satisfactory when geared to run the machine at an average speed suitable for all work. The machines of this line range in weight from 15,000 to 46,000 pounds.

BESLY VERTICAL DISK GRINDER

A 42-inch vertical-spindle disk grinder, driven direct from a motor built into the base, has been brought out by Charles H. Besly & Co., 120 B N. Clinton St., Chicago, Ill. This machine (the No. 39) is shown in the illustration fitted completely for wet grinding, with a motor-driven pump and an automatic starter. The motor is of 20-horsepower capacity, and has a speed of 575 revolutions per minute. When it is desired to use the machine for dry grinding, the pump and piping are omitted, and a connection is made to an exhaust system or a motor-driven exhauster.

An important feature is that the tank which contains the coolant is cast integral with the top casting of the motor so as to surround the motor completely and protect it from all dirt or water. Three large clean-out holes located in the bottom of the tank are fitted with hand-hole plates which can be quickly removed for cleaning the tank. A removal guard ring, projecting two inches above the grinding face, surrounds the disk wheel. This ring prevents work from flying off the wheel while being ground and directs grindings and coolant into the tank below. Cross-bars fastened to the top of this guard ring prevent the work from revolv-

Besly Vertical-spindle Disk Grinder driven by a Motor in the Base

ing with the disk wheel. A wheel-truing device of the same design as is used on the Nos. 19 and 29 machines built by this company, can be furnished on this machine. The vertical spindle is 3¾ inches in diameter, and can be lifted out of the machine completely assembled with bearings, bearing bushings, and the rotor. The weight of the machine is about 3140 pounds.

KEARNEY & TRECKER MOTOR-IN-THE-BASE MILLING MACHINES

An individual drive from a motor enclosed within the lower part of the column is now furnished in a line of eight plain, universal, and manufacturing type milling machines built by the Kearney & Trecker Corporation, Milwaukee, Wis. Not only is a substantial saving in floor space obtained with this design, but the motor is protected from dirt and dust, there are fewer corners where dirt can accumulate and the installation is quiet, compact, and economical. The machine is well adapted for use in shops in which an individual drive is required for each machine.

As in other machines built by this company, that are equipped with direct-geared drives, no chains or belts are

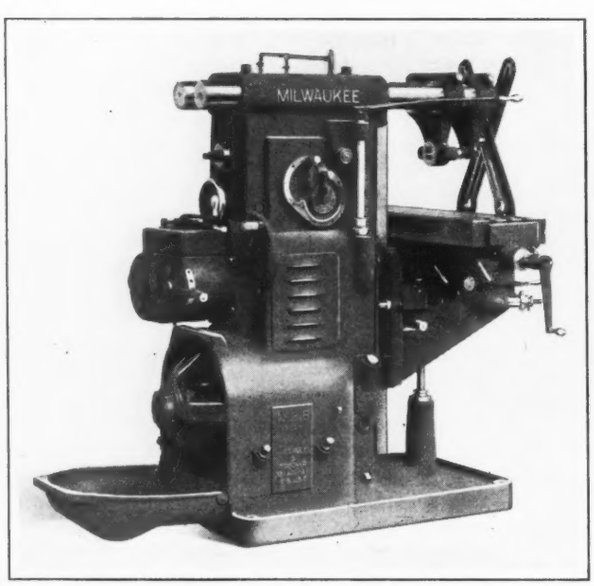


Fig. 1. Kearney & Trecker Motor-in-base Milling Machine

used between the motor and the driven members. The driving pinion on the armature shaft meshes direct with the driving gear of a train that leads up through the column. The motor is placed with the driving pinion toward the front of the machine so that the brushes and commutator can be reached by merely removing the hinged cover at the rear of the column. The entire motor can be quickly slid out of the housing for making adjustments or repairs. Lubrication of the motor bearings is amply provided for, and may be taken care of from the outside of the machine. Adequate provision is also made for ventilation of the motor, overheating having been obviated under severe tests.

In addition to the motor drive, two other improved features have been incorporated in this machine. One of these is a friction clutch, the control lever of which extends to the front of the machine. This lever may be adjusted to any angle to suit the convenience of the operator or swung completely out of the way to accommodate large work. The other improvement consists of a built-in power rapid traverse for the table. A lever at the front of the table is manipulated to engage the table-driving mechanism in a direction determined by the lever movement, and a second lever at the right hand of the operator is lifted to make the table move either at a feeding rate or at the power rapid traverse rate. The levers are separated so that the movements cannot be confused. Other levers for controlling the engagement of the cross and vertical feeds, are located in convenient positions, completely separated from the table control levers. This new line of machines is equipped with automatic means of lubricating the gears in the column and the double over-arm, the same as other machines built by this company.

GARDNER OILGEAR SURFACE AND DISK GRINDER

A grinding machine designed to meet the needs of shops where both disk and surface grinding must be performed but where the volume of such work is not great enough to warrant the purchase of one machine of each type, has just been developed by the Gardner Machine Co., 414 E. Gardner St., Beloit, Wis. One of the important features of this machine is the Oilgear hydraulic feed used to effect the longitudinal travel of the surface grinding table. The right-hand end of the machine, which is shown in Fig. 1, may be used for taking heavy cuts on large work or for grinding long parts that could not be handled satisfactorily on a disk grinder. The left-hand end of the machine, as shown in Fig. 2, is regularly equipped with a steel disk wheel and

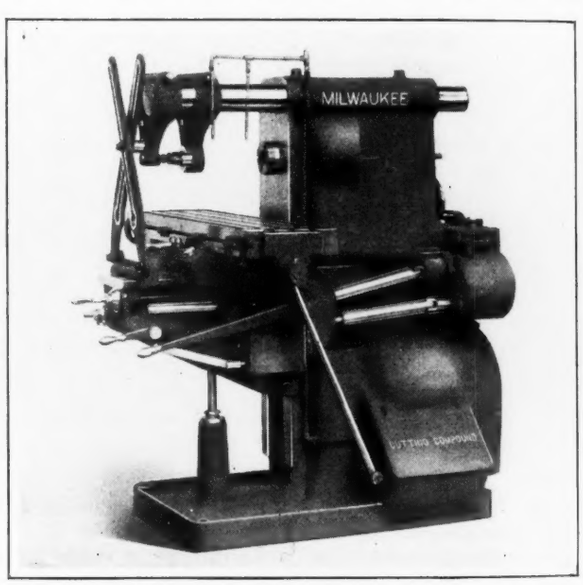


Fig. 2. Right-hand Side of Milling Machine shown in Fig. 1

a universal lever-feed table which adapts this end for all jobs performed on a single-end disk grinder.

The Oilgear mechanism affords a flexible control of the table travel, the rate of travel being quickly regulated through a hand-lever located at the front of the machine. Adjustable stops are provided on the control lever for setting the rate of travel any amount suited to the area of the surface being ground and the material operated on. The table is actuated by a double-acting hydraulic cylinder mounted on the compound slide and direct-connected to the table. Oil pressure is supplied to this cylinder by a variable-delivery pump mounted inside the base and driven from the machine spindle by belt. The pump is entirely enclosed and self-contained, with the oil reservoir built into it.

The table on the right-hand end of the machine is provided with a drain so that when wet grinding is being done, the coolant returns to a tank at the rear. The longitudinal movement of this table is controlled by means of stops placed in a T-slot on the front side of the table which contact with a pilot valve operated from the hydraulic system. When this contact is made, the travel is automatically reversed. Feeding of the work to the grinding wheel is accomplished through a hand-operated micrometer screw graduated to 0.001 inch. The compound slide is supported by a knee which is adjustable vertically through a screw operated by turning a handwheel. The universal lever-feed table

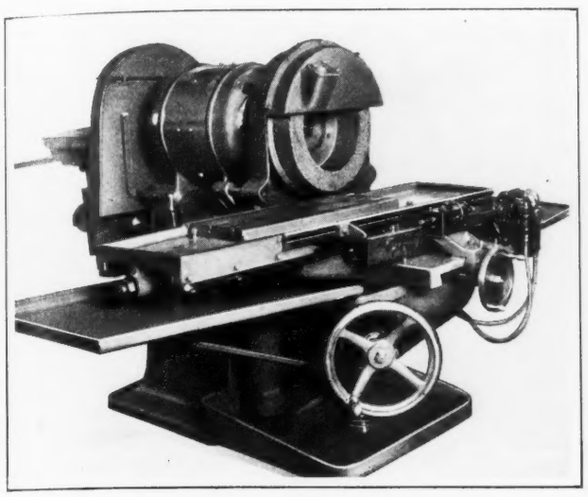


Fig. 1. Gardner Combination Surface and Disk Grinder equipped with an Oilgear Table Feed

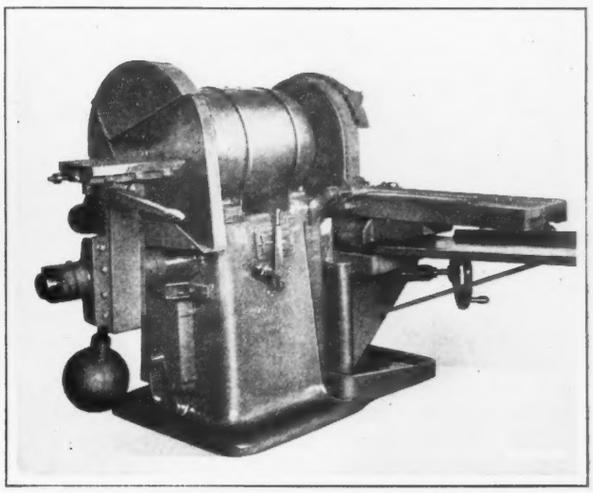


Fig. 2. Left-hand or Disk-wheel End of the Grinding Machine illustrated in Fig. 1

at the left-hand end of the machine is provided with large rocker boxes to insure ample support.

In the motor-driven type shown, the motor shaft serves as the machine spindle. The right-hand end of this shaft carries an 18-inch abrasive ring wheel mounted in a chuck, which is interchangeable with a 20-inch steel disk wheel. The left-hand end is equipped with a 23-inch steel disk wheel faced with a heavy-type abrasive disk. A Ross dresser is furnished for truing the ring wheel and a lever-table dresser, for truing the disk.

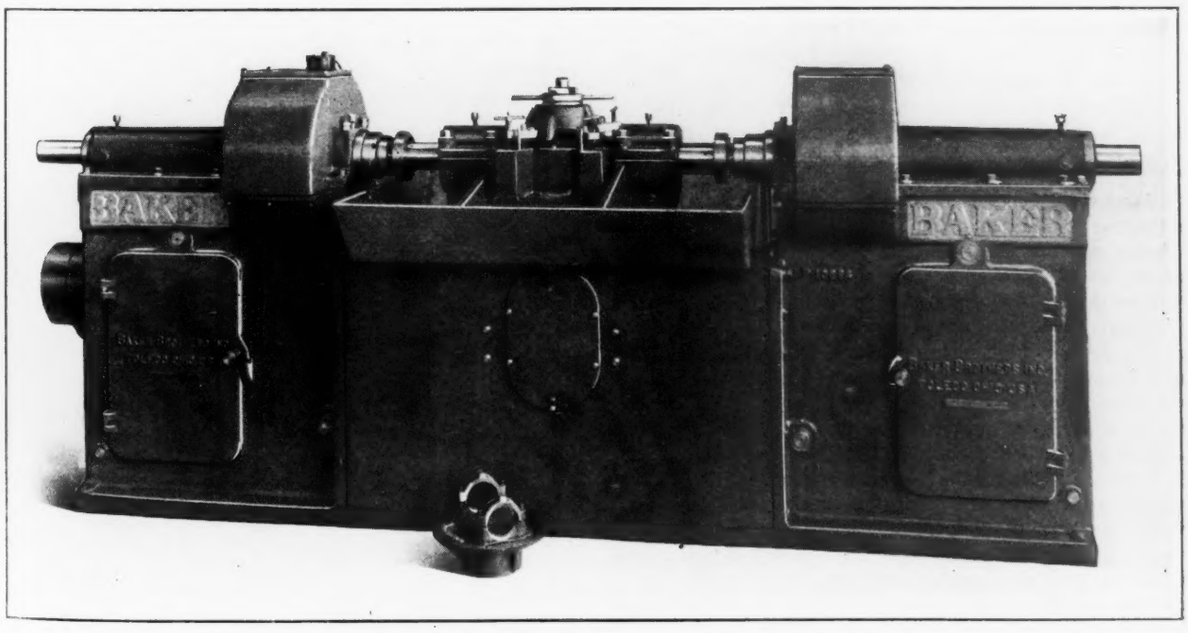
BAKER BROS. TWO-WAY CAM-FEED MACHINES

Two-way boring, drilling, and tapping machines of horizontal design, provided with opposing heads which may be equipped with one or more spindles, have recently been developed by Baker Bros. Inc., Toledo, Ohio. When the heads are each equipped with but one spindle, these spindles are actuated longitudinally by cams which give an automatic rapid advance, a feed and a quick return, the mechanism then stopping. These cams are made special to suit the particular job for which the machine is intended. Among the advantages claimed for the cam feed, in addition to a close control of the rapid advance and quick return, are a close control of the feed and the convenience of facing accurately to depth. Doors are provided at the front of the machine to make the cams and feeding mechanism readily accessible.

The central section of these machines is made any length to suit the job, the machine illustrated being arranged for rough- and finish-boring and tapping operations on a differential carrier. Either a belt or a motor drive can be furnished, although a motor drive is recommended. A five-horsepower motor running at 750 revolutions per minute is suitable. The motor is coupled direct to the main drive shaft, and a solenoid brake is applied to the armature shaft so as to stop the spindle immediately at the completion of the cycle of operations. When equipped with a multiple number of spindles, the heads slide on ways. The weight of the standard machine equipped with heads having one spindle each, including the motor, is about 4200 pounds.

LINK-BELT SAFETY COLLARS

Malleable-iron safety collars for holding pulleys, shaft bearings, hangers, etc., in alignment are being made in both split and solid types by the Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill. Both types are machine-finished for accuracy and appearance. The two sections of the split collar are held together by set-screws, which are also used to clamp the collar to the shaft. Flanges on the castings protect the heads of these screws.

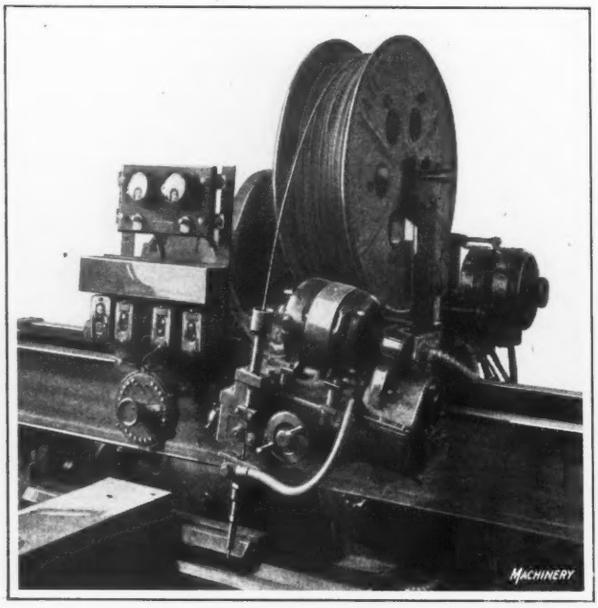


Baker Bros. Horizontal Two-way Boring, Drilling, and Tapping Machine

GENERAL ELECTRIC AUTOMATIC WELDING CARRIAGE

A "travel" carriage has recently been developed by the General Electric Co., Schenectady, N. Y., to simplify the process of automatically arc-welding straight seams. It is intended for use in production work where similar welds are made repeatedly. As shown in the illustration, this carriage consists of an automatic welding head, control mechanism, travel motor, and wire-reel support, all of which are mounted on a frame provided with wheels for rolling along a track. The welding head and control are mounted on the apron of the carriage, and feed the electrode wire from a reel to the arc. The reel is carried by supports attached to the carriage frame.

Both the welding head and the travel motor are controlled from one push-button, the control being so inter-locked that when the starting button is pushed, the arc is automatically established simultaneously with the starting of the motor. Should the arc fail for any reason, the motor will stop without over-traveling. When the arc re-establishes itself, the motor will start again without any attention from the operator, and thus insure a continuously welded seam. An adjustable time-limit switch stops the motor at the end of the weld, the carriage then being returned to the starting position, either by hand or electrically.

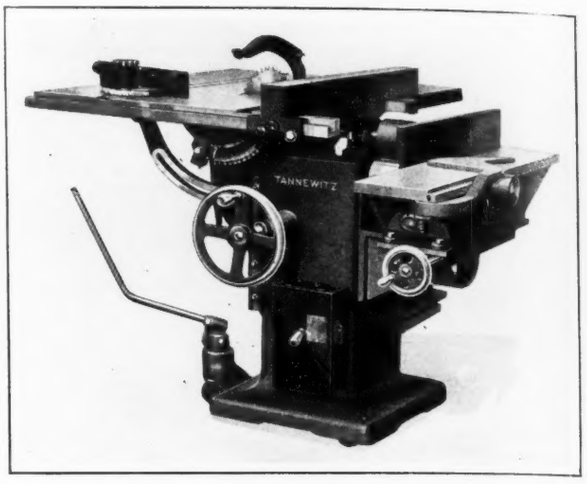


General Electric Automatic Carriage for Use in Production Arc Welding

TANNEWITZ PORTABLE WOODWORKER

A large-sized portable combination woodworking machine that comprises a tilting-table saw bench and a 6-inch jointer, is being manufactured by the Tannewitz Works, Grand Rapids, Mich. The outfit is mounted on a three-wheeled truck so that it can be conveniently moved about the shop. By raising the handle, the base is lowered into contact with the floor to seat the machine for use. The truck wheels are again brought into contact with the floor and the machine base raised, by simply depressing the handle. The machine may be used to rip, miter, cross-cut, bevel, groove, rabbet, joint, or plane work.

The saw bench table is 30 by 36 inches in size, and is regularly furnished with a pair of 12-inch saws which protrude 3 inches through the table. The largest saw that can be used is 15 inches in diameter. The machine has a capacity for ripping of 17 inches in width. Tilting of the table can instantly be accomplished to any angle up to 45 degrees. The jointer knives are made of high-speed steel; they are 6 inches long and are mounted on a safety cylinder provided with pins at the ends so that the knives cannot fly out. A two-horsepower motor for driving the machine is mounted on an adjustable bracket at the rear of the base.



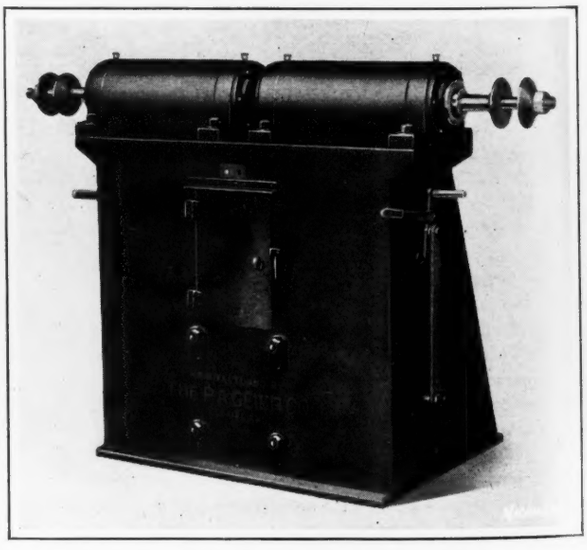
Tannewitz Portable Combination Saw and Jointer

GEIER POLISHING AND BUFFING LATHE

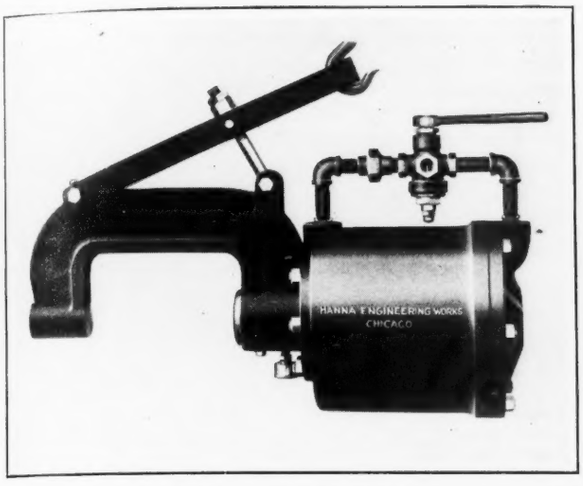
An electrically driven polishing and buffing lathe, in which the motor, idler pulleys, brake mechanism, and control box are all contained within the base, is being introduced on the market by the P. A. Geier Co., Cleveland, Ohio. The motor is of the squirrel-cage type, and is mounted on a sub-base bolted to the internal front side of the bed. The bed itself is provided with slots, permitting vertical adjustment of the motor to compensate for stretch of the endless belts that drive the spindles. A 5-, 7½-, or 10-horsepower motor can be furnished.

The belt idlers are mounted on ball bearings and engaged by counterweights. They are controlled through a hand-lever on the outside of the machine, which also operates a toggle brake to stop the spindles and lock them when it is desired to change wheels. The brake is lined with Raybestos. The spindles and bearings are made dustproof by a system of baffles, and the spindle housing is enclosed in a sheet-metal hood that further reduces the possibility of dust gathering within the mechanism.

The power delivered to the machine is controlled by push-buttons located on the front near the top. Practically any speed from about 1800 to 3000 revolutions per minute is obtainable by changing the driving pulleys. The spindle at one end may be run at a given speed, and the other spindle at another speed.



Geier Polishing and Buffing Lathe



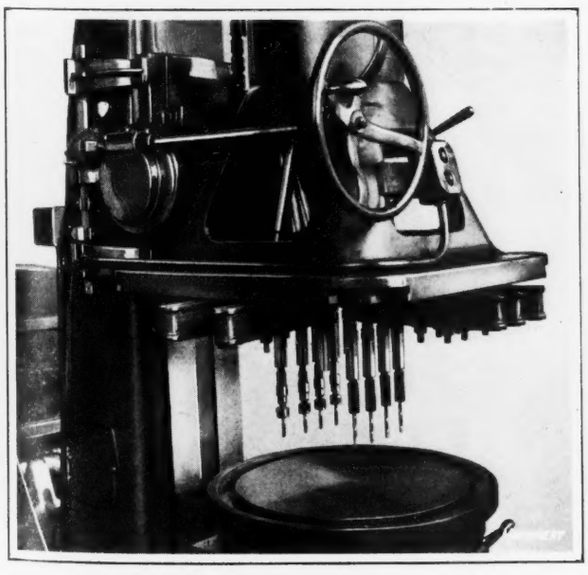
Hanna Straight-acting Pneumatic Press

HANNA STRAIGHT-ACTING PRESS

A recent addition to the line of riveting machines and kindred equipment manufactured by the Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill., is the straight-acting pneumatic press shown in the accompanying illustration. This machine has a reach of 4 inches, a gap of 6 inches, and a die stroke of 2 inches. The cylinder is 12¼ inches in diameter, and is capable of exerting a force of 5 tons on the dies, with an air pressure of 100 pounds per square inch. Rivets up to 3/16 inch can be driven cold, and up to ¼ inch hot. The weight is approximately 225 pounds. One application of this equipment is the riveting of dust disks to rear axle assemblies in an automobile plant.

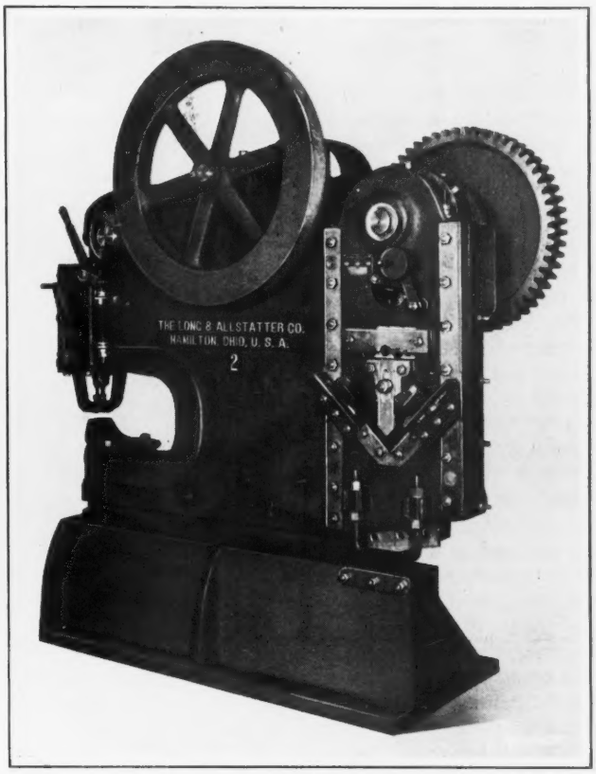
HARRINGTON ELECTRICAL TAPPING REVERSE

Multiple-spindle drilling machines built by the Harrington Co., 17th and Callowhill Sts., Philadelphia, Pa., may now be equipped with an electrical arrangement for automatically reversing the rotation of the spindles to back out taps from finished holes. This arrangement reverses the direct-connected motor used to drive the machine. Tapping is performed at the drilling speeds, so that work can first be drilled and then tapped without removing it from the fixture. The motor reversal is so controlled that it does not interfere with the use of the power feed for drilling.



Harrington Multiple-spindle Drilling Machine equipped with Electrical Tapping Reverse

The illustration shows a close-up view of the control. There is a bar attached to the left-hand side of the head at the rear, on which adjustable stops are carried. These stops engage a double push-button switch mounted on the column, thus operating the automatic reversing self-starter and the motor. The reversal of the spindles to full speed in the opposite direction takes place in only about two seconds, but this length of time is sufficient for the motor to stop and accelerate in the reverse direction, gradually taking up the backlash in the gearing and universal joints. The shocks obtained by mechanical reversal are eliminated. Another advantage is that the point of reversal can be accurately governed, which is of particular value in tapping holes where the depth must be held within limits. This type of reversal can be supplied with both direct- and alternating-current motor drives.



Long & Allstatter Punching and Shearing Machine for General Use

LONG & ALLSTATTER PUNCH AND SHEAR

A punching and shearing machine of new design, intended for general use, is being placed on the market by the Long & Allstatter Co., Hamilton, Ohio. This machine will punch holes in plates, angle-irons, and other structural shapes; shear angle-irons (square or mitered), or round, square, or flat stock; and split plates. All these operations may be performed without changing the tools, as the punches and also the various shear blades are always set up in readiness for use.

The main frame is an annealed steel casting, proportioned with ample strength to withstand severe use. The shear slide is made of steel and operates in bronze liners. A lowering device on the punch slide enables the operator to gage the punch closely with the work. The blades have four cutting edges and are made of tool steel. They are easily changed. All the gearing is made of steel, with machine-cut teeth, and the shaft bearings are bronze-bushed. Various sizes of these machines will be built, the smallest of which will have a capacity for punching ¾-inch round holes through ¾-inch material, and the largest, 1½-inch holes through 1-inch material. The shearing capacities will be in proportion to the punching capacities.

LIBERTY PLANER

A number of new and improved features are incorporated in a planer that has just been brought out by the Liberty Machine Tool Co., Hamilton, Ohio. One of the most important features of this machine is that the cross-rail is a self-contained unit, carrying all the mechanisms necessary for the power rapid traverse of the heads vertically and horizontally and for elevating and lowering the cross-rail. Unclamping, elevating, lowering, and reclamping of the cross-rail, as well as the power rapid traverse of the heads vertically and horizontally, are all accomplished by the manipulation of lever *A*. This design eliminates the possibility of engaging two different movements at one time, and thus provides a fool-proof control of the rail. Feeding of the two heads vertically and horizontally is controlled through levers *B* and *C*, while the rate of feed is regulated by turning handwheel *D*. The rate of feed for which the mechanism is set at any time can instantly be determined by simply referring to indicator *E*.

Power for the rapid traverse of the heads and for elevating and lowering the rail, is delivered by a 1½-horsepower motor built into the back of the rail. This motor receives current through protected trolleys that contact with conducting strips of metal fastened vertically to the outside of the right-hand housing. Either alternating or direct current can be used and, if necessary, it may be taken from a lamp socket. Both heads are moved by the rotation of a nut on a single stationary screw that is in tension at all times. It is unnecessary for the operator to go to the left-hand side of the machine to engage or disengage the horizontal feed of the left-hand head or the vertical feed of the left-hand tool-slide. These movements are controlled through lever *F*, while lever *G* similarly controls the right-hand head and tool-slide.

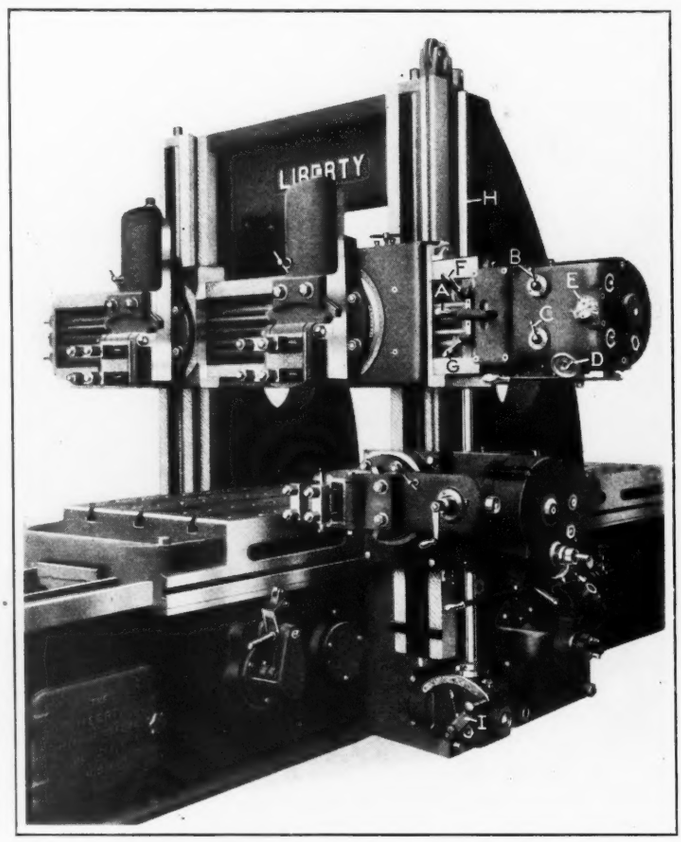


Fig. 1. Liberty Planer with Self-contained Cross-rail and Other Improved Features

The vertical movement of each tool-slide is also accomplished by revolving a nut around a stationary screw that is kept in tension, the same as the horizontal cross-rail screw. Also, the screws for elevating and lowering the cross-rail are stationary and held in tension. These screws really serve a double purpose, as they are used for the feed and power rapid traverse of the side-head, in addition to giving movement to the cross-rail. This construction eliminates two of the screws common on a four-head planer. An individual motor mounted on the side-head drives the nut of this head. The clamps for locking the cross-rail to the housings are located on the inside of the housings and are operated through lever *A*, as previously mentioned.

The vertical shaft *H* is used only for transmitting power to the feed mechanism of both rail heads and the side-head. The transmission gears are so arranged that by moving lever *I* into two different positions, the feed may be made to take place at the end of a cut or just before starting a new cut. All mechanisms on the end of the cross-rail and on the side-head for controlling the feed and power rapid traverse, and also the feed-reversing mechanism at the bottom of the housing, run in oil. Gages indicate the level of the oil at these points.

Attention is called to the fact that there is no mechanism on top of the planer, with the exception of the sheave wheels which carry the cable of the counterweight provided for the side-head. This counterweight is contained within the housing. The housings extend to the floor, and are attached to the bed by means of bolts fitted into reamed holes. Additional heavy dowel-pins eliminate any movement between the housings and the bed. The latter is of the double-wall type, ribbed lengthwise and crosswise and webbed on top. It is arranged for forced-feed lubrication through a system, the pump and control valve of which are located on the outside of the right-hand housing. There is also a sight-feed attachment

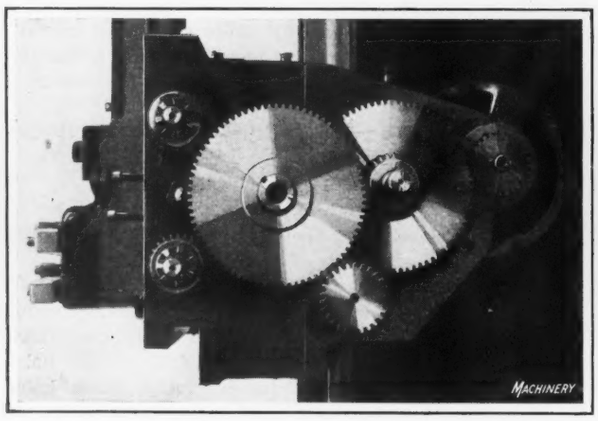


Fig. 2. View of Motor and Driving Gears on Left-hand End of Cross-rail

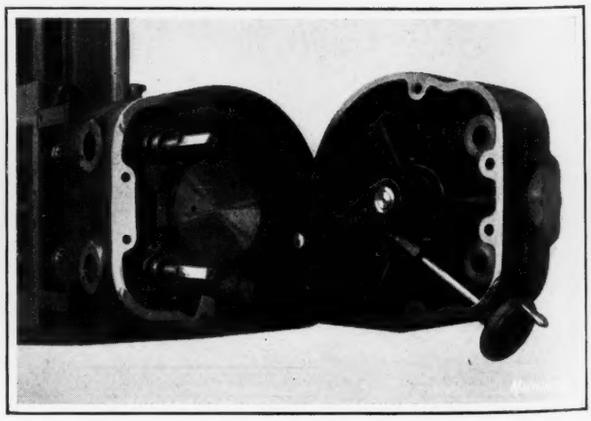


Fig. 3. Housing on Left-hand End of Cross-rail opened to show Part of the Mechanism

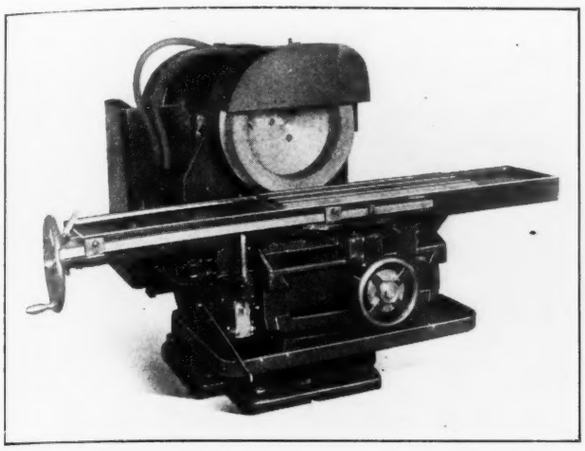


Fig. 1. Badger Grinding Machine equipped with a Power-operated Face Grinding Table and a Lever-feed Table

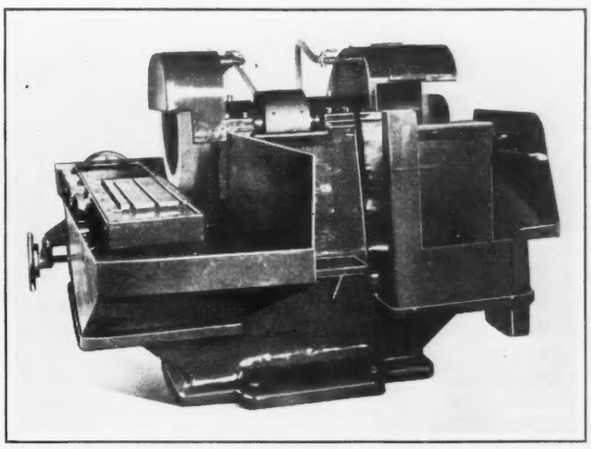


Fig. 2. End View of the Badger Grinding Machine illustrated in Fig. 1, with the Water Guards in Place

there by means of which the operator can readily tell whether the system is functioning. Oil reservoirs are located between the double walls. All oil entering bearings must first be filtered through the various filtering stations in the bed and then passed through a ½-inch felt wick. The pump is of the two-way type. The bed is of double length so that the table never passes beyond the ends.

Herringbone gears are used in the drive with a view to obtaining a balanced drive and eliminating friction and side thrust. The gears are made of heat-treated steel; they are contained in a box cast into the bed and run in a bath of oil. The table is of box-type construction and has wide openings at the bottom of the T-slots to allow chips to fall into a space from which they may be conveniently removed through openings in the sides of the table. This construction does away with the necessity of cleaning the T-slots of chips from above before inserting clamping bolts.

BADGER GRINDING MACHINE

A combination grinding machine, one end of which is fitted with a power-operated face grinding table, and the other with a lever-feed table, is shown in the accompanying illustrations. This machine (known as the No. 8) has just been placed on the market by the Badger Tool Co., Beloit, Wis. If desired, it can be supplied with two face grinding tables or two lever-feed tables, either right- or left-hand, and these tables may be hand- or power-operated. When the machine is equipped with two power-operated tables one man can tend both ends. In the illustrations, the machine is arranged for wet grinding, and is equipped with a power-operated face grinding table, 73 inches long by 13 inches wide. The finished working surface is 32 by 10 inches; the longitudinal travel, 34 inches; and the in feed, 5 inches.

Two table speeds, of either 3 or 15 feet per minute, can be furnished. At the slower speed, the table is driven through a nut and screw, the screw automatically reversing when the control handle comes in contact with adjustable stops that determine the length of travel. At the fast speed of 15 feet per minute, a rack and pinion are substituted for the screw and nut. When the table is arranged for operating by hand, the spider handwheel is used. There is no vertical adjustment for the table, it being intended that the fixtures for holding the work shall be so constructed as to make the center of the piece being ground coincide with the center line of the machine spindle. Both ends of the machine are equipped with 20-inch abrasive ring wheels. The machine can also be arranged for dry grinding. The weight, equipped as shown and including a countershaft, is about 5000 pounds.

"LO-SWING" BACK SQUARING ATTACHMENT

The latest attachment developed for the "Lo-swing" lathe manufactured by the Seneca Falls Machine Co., Seneca Falls, N. Y., is for use in performing squaring, grooving, forming, facing, or similar operations. As shown in Fig. 1, there are two sets of tooling at the back of the machine, each mounted on a slide which, in turn, is mounted on a base clamped to the bed of the machine. The two slides are fed toward the work by means of the cams illustrated

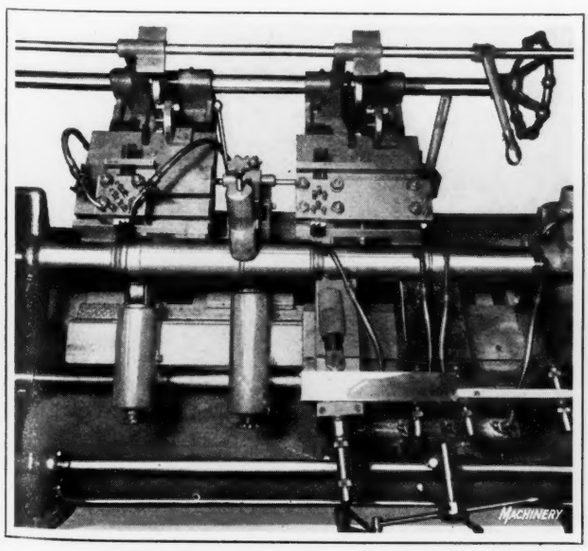


Fig. 1. "Lo-swing" Lathe with Attachment for Squaring, Grooving, Forming, and Facing Operations

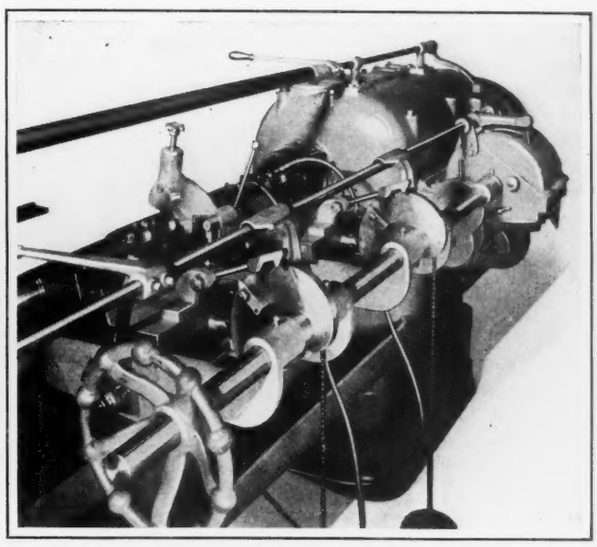


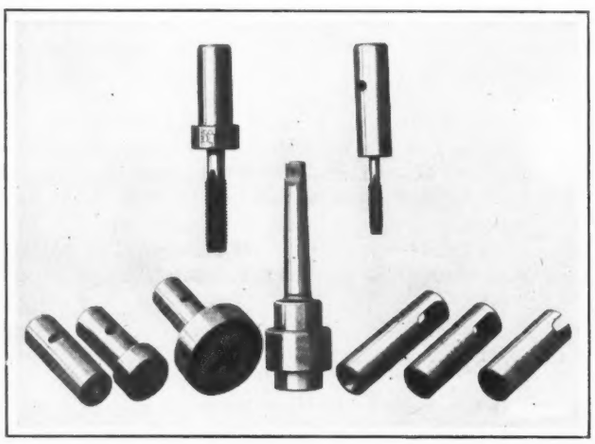
Fig. 2. Cams employed to move the Tool-slides of the "Lo-swing" Lathe toward and from the Work

in Fig. 2, each of which contacts with a roller fastened to a slide. The shaft that carries the cams runs along the back of the machine and is driven directly from the head through worm-gearing.

The drive to this camshaft is so arranged that in starting an operation, the initial movement of the cams is rapid. But when the camshaft has rotated to a certain point, a slow speed is thrown in, so as to make the cams revolve slowly while the tools are cutting. When the cuts are completed, the mechanism is again tripped and the cams revolve fast until the slides are completely withdrawn. Then the feed mechanism is thrown out and remains disengaged so that the machine may be reloaded for the next operation. An advantage of the cam feed is the possibility of feeding the tools at varying rates. It is stated that because of the smoothness and rigidity of the operation, the finish obtained on the part shown is so smooth that the polishing operation formerly given this part has been discontinued.

PROCUNIER DOUBLE-JAW QUICK-CHANGE CHUCK

To adapt a single-spindle drilling machine to the performance of a variety of operations in quick succession, William L. Procunier, 18 S. Clinton St., Chicago, Ill., has



Procunier Quick-change Chuck and Collets

recently developed a double-jaw quick-change chuck. By using this chuck, tools may be changed without stopping the machine. The operator simply lifts up a sleeve or collar, allowing two balls to slide out of a pocket in the collet. The tool then drops into the hand of the operator and he may substitute another without shifting the position of the work. Several types of collets are made to handle all classes of tools, such as taper-shank drills and reamers, machine taps, round button dies, etc. An assembled chuck and several collets and tools are shown in the illustration. The collets and chuck are made of hardened steel, and ground.

CLEVELAND WORM-GEAR REDUCTION UNIT

Another size has been added to the line of worm-gear reduction units manufactured by the Cleveland Worm & Gear Co., Payne Ave. and E. 40th St., Cleveland, Ohio. This size 0 equipment is intended for continuously transmitting loads not exceeding 3 horsepower. It is available in standard ratios of 5 to 1, 10 to 1, 15 to 1, 20 to 1, 25 to 1 and 30 to 1. Another application is as a speed booster in the 1 to 5 ratio. The unit is fully

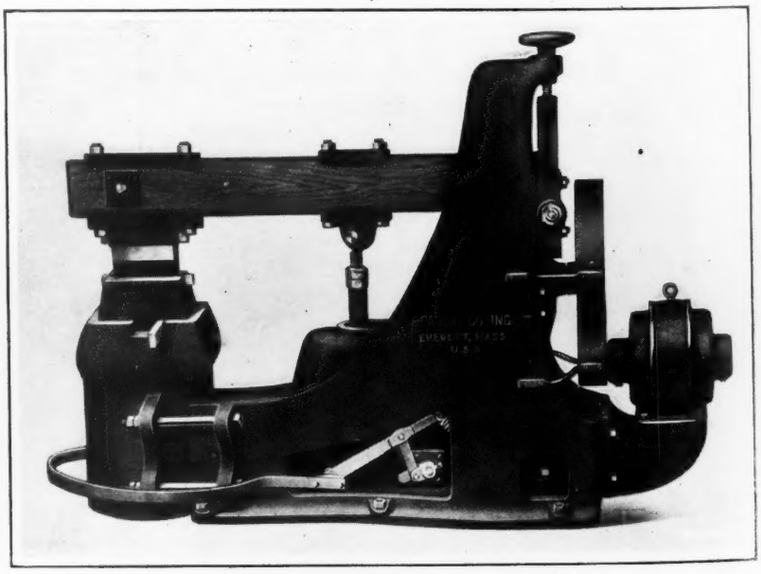
Cleveland Worm-gear Speed Reduction Mechanism

enclosed and self-oiling, the oil capacity being ample to insure an efficient operating temperature under all conditions. The worm is a nickel steel forging, and the gear is made of bronze. The worm bearings are of the radial thrust ball type, and the gear shaft is mounted on special Timken bearings. The gear shaft may be extended from either or both sides, and the worm may be rotated in either direction.

BEAUDRY AIR-CUSHIONED HELVE HAMMER

A helve hammer in which the blows are cushioned entirely by air is built by the Beaudry Co., Inc., Parkway at Vine St., Everett, Mass., in four sizes equipped with from 40- to 200-pound rams. An advantage of the construction is that the first blow of the hammer, at the beginning of its operation, is just as powerful as successive blows. Either a light tap or a heavy blow can be delivered at full-speed operation, the force being regulated by the amount of pressure exerted on the foot-treadle, the same as on previous machines. A rotary valve in the air line is operated by the foot-treadle. The speed of the hammer is not affected, of course, by the movement of the treadle. When the hammer is at rest, the helve is lifted and the dies spread apart ready to receive work. The machine may be driven by belt or by a motor.

In order to make the hammer self-contained, an air com-



Beaudry Helve Hammer cushioned by Air

pressor is cast in one piece with the helve-actuating cylinder. The "power plant" is separate from the main frame and easily removed from it. In adjusting the dies to suit different thicknesses of work, four nuts are loosened on the pivot yoke, and the handwheel on top of the machine is then turned to raise or lower the yoke the proper amount, after which the four nuts are retightened. The connecting-rod of the helve is adjusted by means of a turnbuckle. The helve pivots on hardened steel centers which are easily adjustable. Side play of the dies can be eliminated so that they will always register with each other. The small sized machine is intended for work averaging 1¼ inches in thickness; it makes 300 blows per minute and weighs about 3200 pounds. The largest machine is intended for work averaging 3¾ inches in thickness, and it makes 230 blows per minute, and weighs approximately 9500 pounds.

BRIDGEPORT RADIAL GRINDER AND BUFFING LATHE

A swing-frame grinder, operated without belts, countershafts, or any overhead suspension, has recently been introduced to the trade by the Bridgeport Safety Emery Wheel Co., Inc., 83 Knowlton St., Bridgeport, Conn. The grinding wheel of this equipment may be operated in or out, up or down, or around a complete circle, and the machine may be

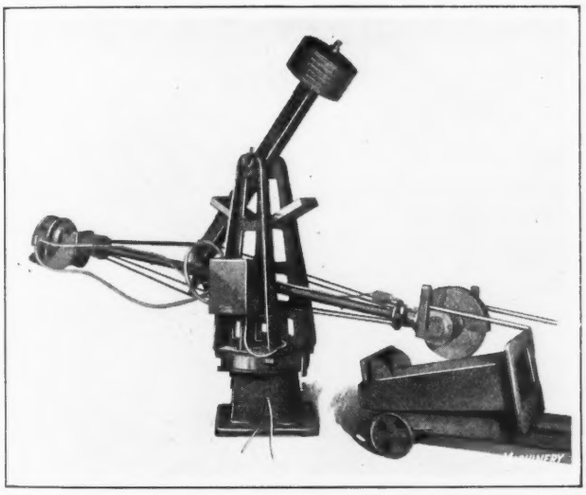


Fig. 1. Bridgeport Counterbalanced Beltless Grinder

served on all sides by cranes. It consists essentially of two counterbalanced arms mounted on a horizontal plate which may be rotated to any position. As these arms are always in balance, the center of gravity remains over the center of the base, and so the operator may let go of the handles at any time, whether the machine is running or not, and the wheel will remain practically where he left it. The grinding wheel at one end of the horizontal arm is counterbalanced by the motor at the other end. This arm is a tubular member that is trussed with rods to provide strength and stiffness.

Power is transmitted from the motor to the spindle by a shaft that runs through the tube and is connected to the spindle by bevel gears. This shaft is carried by three ball bearings, and the spindle is also equipped with ball bearings. Horizontal rotation is easily effected, as the entire weight of the rotating member is carried on a circle of steel balls. The machine is regularly furnished ready for hooking up to an electric circuit, with a push-button control for the grinding head. The space required for a complete movement of this machine is a circle 20 feet in diameter. The approximate weight is 2300 pounds.

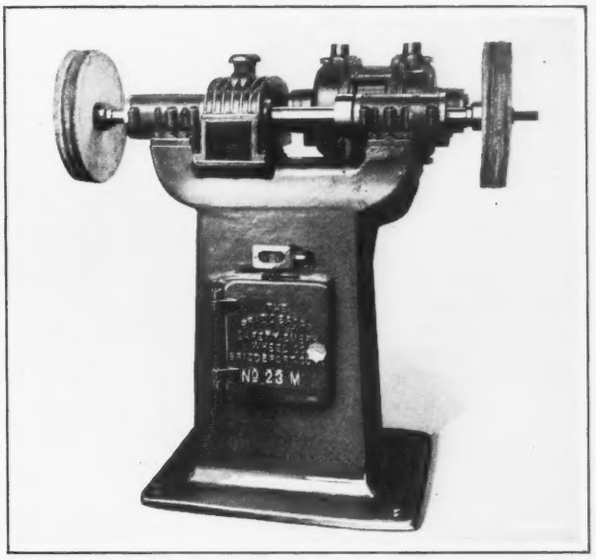
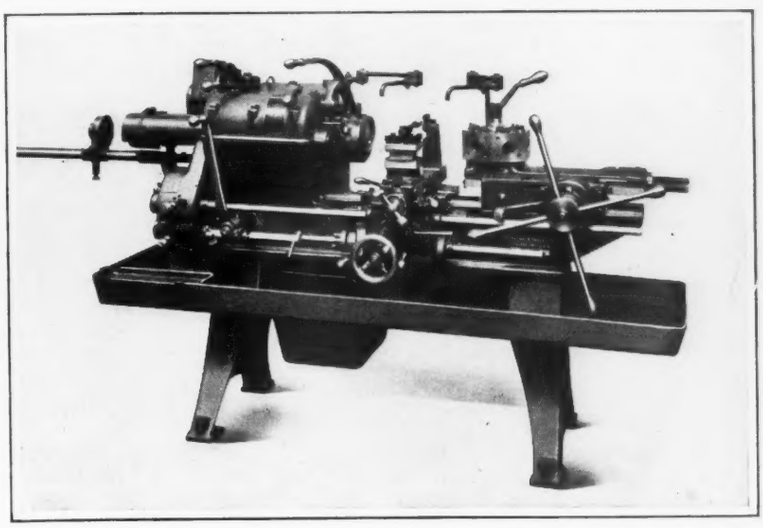


Fig. 2. Motor-driven Buffing Lathe built by the Bridgeport Safety Emery Wheel Co.

The same company is also bringing out the motor-driven buffing lathe shown in Fig. 2, which is built in three sizes equipped with 2-, 5-, and 7½-horsepower motors, respectively. In each case a silent chain is used to connect the motor to the buffing spindle, and by using appropriate sizes of sprockets, the spindle speed can be changed as desired. The motor is mounted on a bracket cast to the back of the pedestal. The silent chain runs in an oil-tight case having an oil bath at the bottom to insure continual lubrication. Both the motor spindle and the buffing spindle run in ball bearings. The weight of the three sizes ranges from 970 to 1350 pounds.

WARNER & SWASEY GEARED-HEAD TURRET LATHE

The No. 4 universal turret lathe built by the Warner & Swasey Co., Cleveland, Ohio, for handling small work, is now equipped with an all-geared head which delivers more than twice as much power to the spindle as the cone-type back-geared drive. Any one of twelve forward or reverse spindle speeds, from 30 to 760 revolutions per minute, is instantly available by moving levers on the head. This gives a speed selection that covers all diameters and classes of work accommodated by the machine. There are two tool-



Warner & Swasey Geared-head Universal Turret Lathe

carrying units which have independent power feeds, as on the larger machines. Five cutter positions are available on the standard cross-slide, four on the square turret, and one on the rear toolpost, in addition to six on the hexagon turret.

The machine is well suited to the application of individual motor drive, in which case the motor may be mounted at the rear of the head-end leg for driving the pulley through a belt. When it is necessary to conserve floor space, the motor can be mounted on the head. More than seventy-five small tools are carried in stock for the machine, to provide for a wide range of bar and chucking work. Round bars up to 1½ inches in diameter can be handled with the automatic chuck, and a maximum length of 10 inches can be turned at one setting of the turret saddle along the bed. For chucking work, a geared scroll chuck is supplied, the maximum swing over the ways being 16 inches, and over the carriage guides, 14¼ inches.

CRESCENT ELEVATING TRUCK

A special motor-driven truck of the elevating-platform type has recently been brought out by the Crescent Truck Co., Lebanon, Pa. The new truck is of practically the same design as the one described in November, 1923, MACHINERY, but it is equipped with 15-inch rear wheels and has a carrying capacity of 6000 pounds. Wheels of this diameter give a clearance of 6 inches beneath the platform. The height from the floor to the top of the platform, with the platform lowered, is 17½ inches, and with the platform raised, 22 inches. All tires are 5 inches wide, and the wheels are equipped with roller bearings, the driving unit being carried on ball bearings. The platform is 70 inches long and 26 inches wide.

FOX PRESS AND DRILLING MACHINE

Automobile crankshafts can be straightened under the No. 24 "Superflex" press shown in Fig. 1 provided with special equipment. This machine is one of the products of the Fox Machine Co., Jackson, Mich., and closely follows the design of the press illustrated in December MACHINERY, except that the maximum capacity is 12 tons. The work is held in a fixture that can be readily moved longitudinally under the press ram. The wheels on which this fixture rolls are mounted on yielding supports, and the bearings that support the crankshaft when it is revolved for testing are also yielding. This arrangement provides a solid support on the bed of the press when the ram bears on the crankshaft. Anvils (not shown) are inserted at different points under the work to take the pressure of the ram.

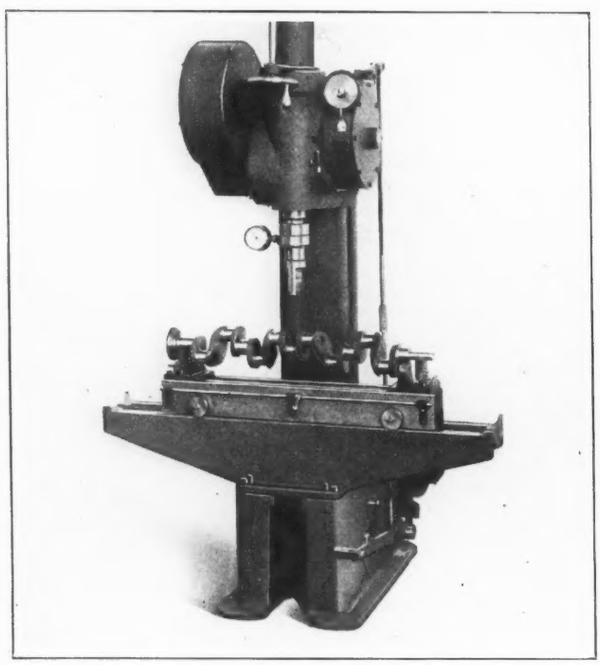


Fig. 1. "Superflex" Press equipped for straightening Automobile Crankshafts

In finish-straightening work of this kind, it is important that the pressure applied shall not exceed the amount required to correct the deflection. Two precautionary measures are incorporated in this machine to guard against excessive pressure. One is a pressure gage on the nose of the ram, and the other is a pressure regulator. The latter consists of an adjusting screw which passes through the front of the brake-drum housing and comes in contact with the lever on the opposite side which is operated by the foot-treadle. The adjustment of this screw determines the amount of pressure that can be exerted on the brake-band, and this, in turn, determines the pressure that the ram will apply to the work. The pressure can be changed to a greater or lesser amount by simply revolving the handwheel on the pressure regulating dial.

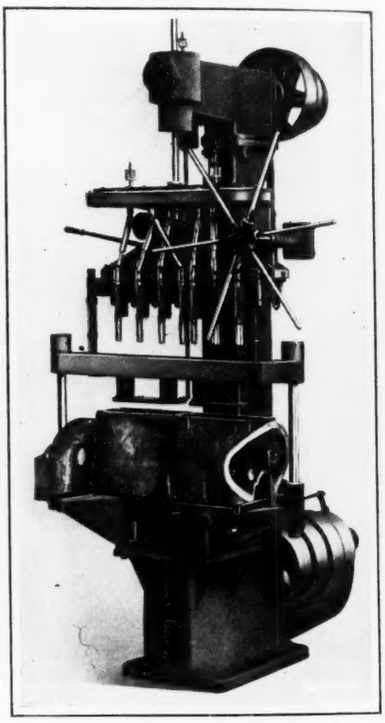


Fig. 2. Multiple-spindle Drilling Machine with Spindles in a Straight Line

Fig. 2 shows a multiple-spindle drilling machine recently built by the same firm for drilling seven holes in a straight line in the crankcase of a six-cylinder automobile. Bushings for the drills are carried in a plate which is attached to the under side of the head. To accommodate this fixture, it was necessary to make a special base for the machine. The drill spindles are adjustable horizontally in the head in a straight line and vertically in their own bearings. There are three speeds and three feeds for the spindles. The weight of the machine is about 2730 pounds.

MONITOR THERMALOAD STARTERS

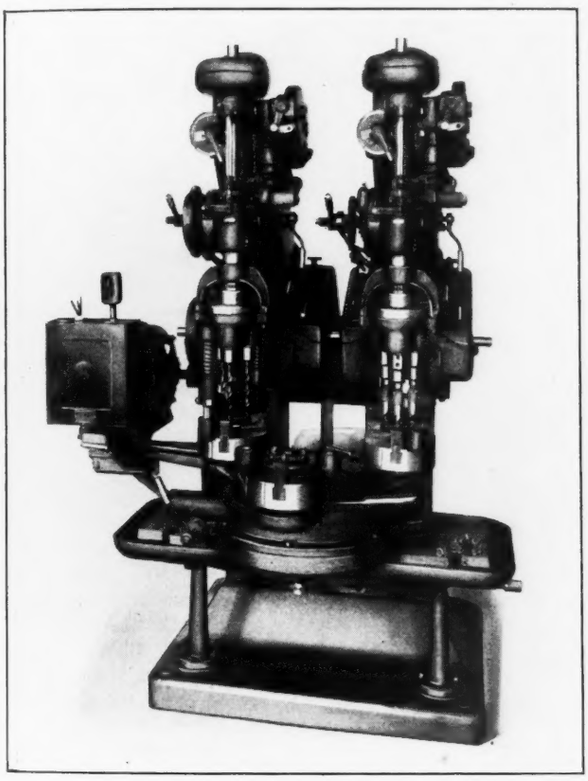
The "Thermaload" starters manufactured by the Monitor Controller Co., Baltimore, Md., for starting small induction motors of both single-phase and polyphase types, are now being built with standard side-arm contactors instead of the special contactor previously furnished. Hair-pin shaped thermal elements are also supplied instead of the previous coiled elements. The new elements are interchangeable with the coiled elements and are of the same size as in the past, to permit changing the horsepower rating of a starter by inserting thermal elements of the proper rating.

TWO-SPINDLE DRILLING MACHINE WITH MULTIPLE HEADS

A two-spindle drilling machine recently built by the Barnes Drill Co., 814 Chestnut St., Rockford, Ill., is equipped with two multiple-spindle heads and a three-station indexing fixture, as shown in the accompanying illustration. The

drive is from a motor controlled by a convenient push-button switch. The spindles are fully automatic in action and time the same. Indexing of the table is done by hand in about two seconds. At each indexing, the spindles make complete cycles and then wait in the uppermost positions until the table has been indexed again. The moment that the locking plunger of the table drops into place, an automatic starter lowers the spindles to the work, and the regular feeds are thrown in for cutting.

The drilling operation at the first station requires just about the same amount of time as the combined reaming, facing, and turning operation at the second station. A combination tool is used to do the three operations at one time. While an operation is in process, the spare station at the front of the table is reloaded. Barker wrenchless chucks of three-jaw construction are used, and these are equipped with floating center plates which permit chucking three



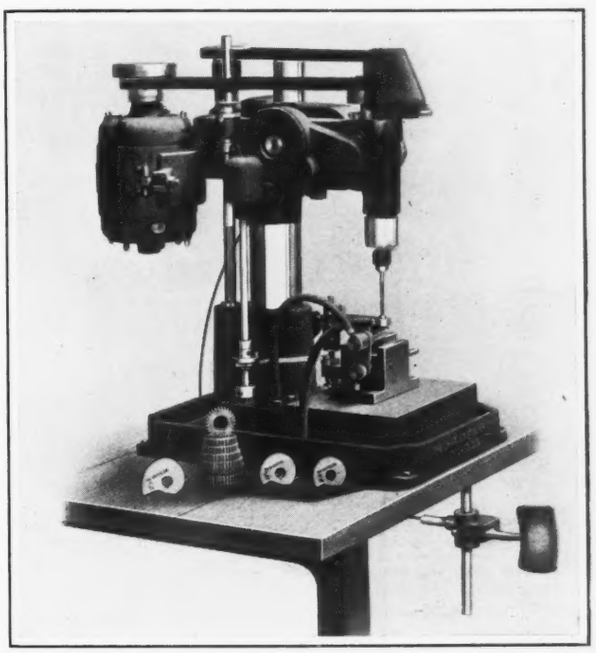
Two-spindle Drilling Machine built by the Barnes Drill Co.

small brass castings at one time. The drill heads are guided by bars, and there is a bushing plate for the drills. The operation illustrated consists of drilling and reaming a 9/16-inch hole 1 inch deep, and of facing and turning one end of the casting. An average of twelve pieces is finished per minute.

STECHER AUTOMATIC DRILLING MACHINE

A universal automatic drilling machine that may be fed by power in large-scale production or by hand in general use, has recently been brought out by the Charles Stecher Co., Inc., 2452-2458 N. Greenview Ave., Chicago, Ill. Both the spindle and motor are equipped with three-step cone pulleys to give three speeds, and change-gears are furnished for regulating the rate of feed to suit conditions. The feed is governed by a cam, three sizes of which are shown in front of the base.

The machine is easily operated, a momentary pressure on the knee control under the bench releasing a positive clutch in the drill head to engage the feed-cam mechanism. This cam then makes one revolution to feed the drill through the work and withdraw it. As the drill approaches the



Stecher Automatic Drilling Machine with Cam Feed

work, the latter is automatically clamped in position by a device operated by the vertical side shaft. This shaft is connected under the base to an air cylinder which, in turn, is connected by means of a flexible tube to a cylinder attached to the jig. As the cam completes a cycle and the clamp is automatically released, the work is ejected by the piston in the jig cylinder.

The feed-cams are so shaped that the idle travel of the drill to and from the work is at a rapid rate. An advantage of the feeding method is that the hands of the operator are always free to reload the work and to press the knee control. In instances where the work can be fed continuously, it is only necessary to apply a constant pressure against the knee control to keep the machine in operation. The machine has a drilling capacity of ¼ inch in steel, and weighs about 260 pounds.

HOLMES SIX-SPINDLE BOLT THREADER

Bolts up to ⅝ inch in diameter and from 1 to 12 inches long may be thread d in a machine developed by the Holmes Engineering Co., Oshkosh, Wis., with the assistance of the Graham Bolt & Nut Co., Pittsburg, Pa. Only bolts having square, hexagonal, or clipped heads, or square or oval shanks, can be handled. The six spindles are tilted at an angle of 30 degrees from the vertical to permit the use of self-clamping slots, provide ample lubrication of the working parts, permit the free washing away of chips, and facilitate the ejection of the threaded bolts into a conveyor. The operator loads and ejects the bolts, but all other steps are automatic, including the conveying of the bolts into boxes.

Twelve synchronized cams are employed, six to start the bolts and six to close the die-heads. These cams act only against counterweights, so that an imperfectly entered bolt cannot break the chasers, nor can a clogged die-head be subjected to excessive strain. Sixty quarts of cutting lubricant flow through the hollow spindles every minute. A complete change of the set-up of this machine can be made in ten minutes, and if the change is merely for the purpose of handling a different length of work, it can be made on all six spindles in about one minute. H. & G self-opening die-heads are furnished.

Under actual working conditions it has been found practicable to cut threads on smaller-sized bolts at the rate of 60 per minute, and on larger-sized bolts, at the rate of 50 per minute. Slower feeds to produce 30 or 40 bolts per

Holmes Six-spindle Bolt Threading Machine

minute can be instantly obtained when threads of unusual length are to be cut or when the operator is unaccustomed to the machine. No chaser speed greater than 30 feet per minute is used.

GENERAL ELECTRIC ELECTRODE-HOLDER

A new welding electrode-holder, manufactured by the General Electric Co., Schenectady, N. Y., allows welding operators to quickly substitute a fresh electrode for a burnt stub. The operator need only knock out the stub, after which the new wire can be instantly inserted. The holder consists of a punched fiber tube having a tinned brass plug inserted in one end. A spring rod holds the electrode in place against one of a number of different-sized notches provided for the purpose. The welding cable running to the source of power is soldered to the other end of the holder. The construction of this holder is such that the contact of the electrode is not weakened by heat.

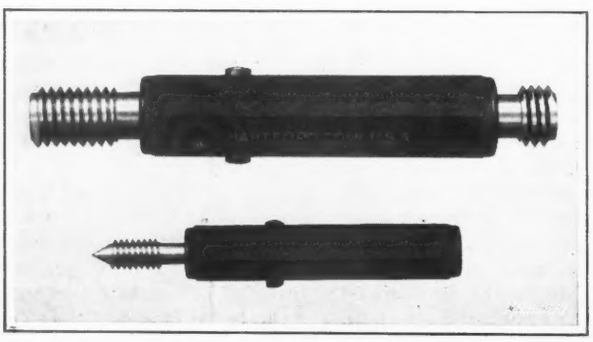


Fig. 1. Hanson Thread Gages with Double Gaging Ends

HANSON "TWIN" THREAD GAGES

Thread gages provided with double reversible ends to give twice the life of ordinary gages are now being placed on the market by the Hanson Tap & Gauge Co., Hartford, Conn. The design can best be understood by reference to Fig. 2. As shown by the bottom example in this illustration, a double-end gage may be screwed into each end of the handle until it seats against a block which is backed up by a wedge pin. This pin is then driven into place to lock the gage firmly in the handle. When the protruding end of the gage has been worn out, a new gage is obtained by simply loosening the wedge pin, unscrewing the gage, reversing it, and fastening it to the handle in the same way as before.

Both ends of the gage plugs are made alike, with the first thread cut away so that when inserting an end in the work, dirt will be scraped away and prevented from wedging between the threads of the gage and those of the hole. The gage plugs are made from either high-speed or tool steel. The handle is left soft, and blocks between the gage plugs and wedge pins are also soft, so that no hardened pieces come into contact with each other. The hole in each end of the handle is tapered, so that when the threaded plug is touched by the wedge pin, the plug and handle have a close fit.

These gages are made in three combinations: First, with twin gages for both "Go" and "Not Go" inspections; second, with a twin gage for the "Go" end and with a tapered "Not Go" end; and third, with a twin gage for one end and no gage in the other. The gages are made in sizes up to 1 inch in diameter and with threads as fine as 100 per inch.

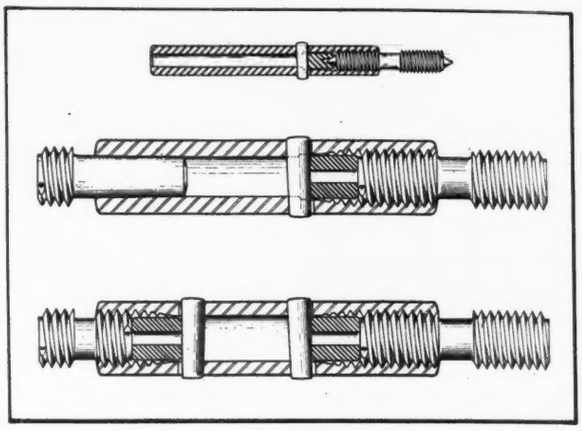
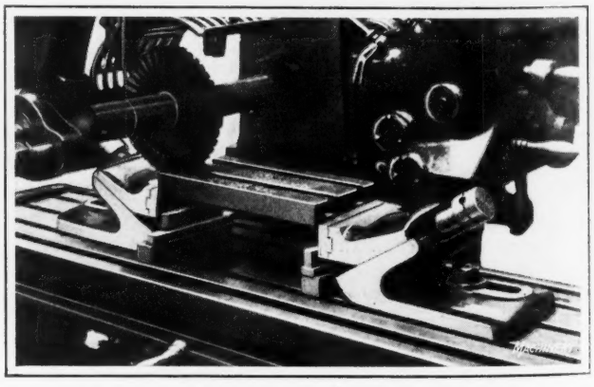


Fig. 2. Sectional Views, showing the Construction of the "Twin" Gages

COATS DIVIDED MACHINE VISES

Machine vises made in two parts so as to provide an unlimited span between the jaws and with the jaws adjustable for height so as to permit holding irregular-shaped parts, are being placed on the market by the Coats Machine Tool Co., Inc., 112 W. 40th St., New York City. Another advantage of the jaws being separate is that they may be used to grip tapered surfaces. Work is seated firmly on the machine table due to the jaws having a compound parallel and downward movement. For clamping irregular-shaped parts, the vise may be used singly, in pairs, or in combinations of three or more.

The body and jaw are each made of close-grained cast iron, the jaw being faced with a hardened steel piece that is serrated to insure a good grip. The screws have right- and left-hand threads, the left-hand thread running in a solid nut on the jaw, and the right-hand thread in a nut secured to the body. Thus, for each revolution of the screw, the jaw movement is twice the lead of the screw. The vises are made in three sizes weighing 6, 40, and 220 pounds,

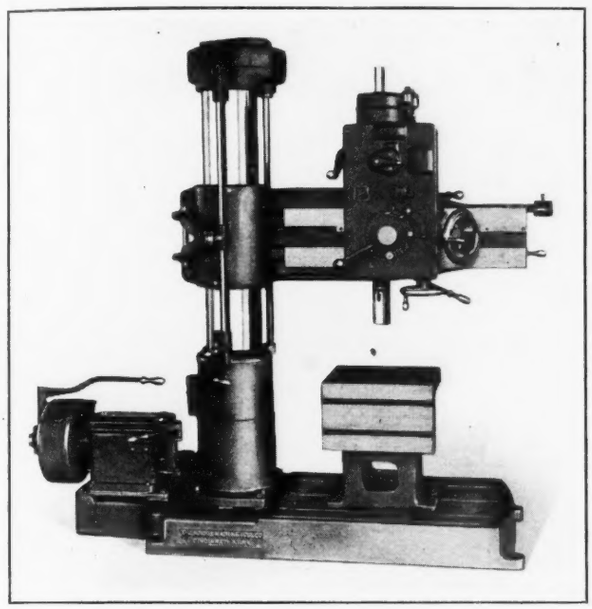


Coats Machine Vises which may be used Any Distance apart

respectively. The width of the jaw on the small size is 2¼ inches; on the intermediate size, 5 inches; and on the large size, 10 inches.

MORRIS RADIAL DRILLING MACHINES

A line of radial drilling machines of the design illustrated has recently been developed by the Morris Machine Tool Co., Court and Harriet Sts., Cincinnati, Ohio. The line includes

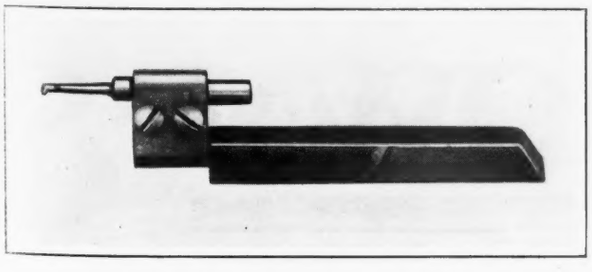


Morris Radial Drilling Machine of New Design

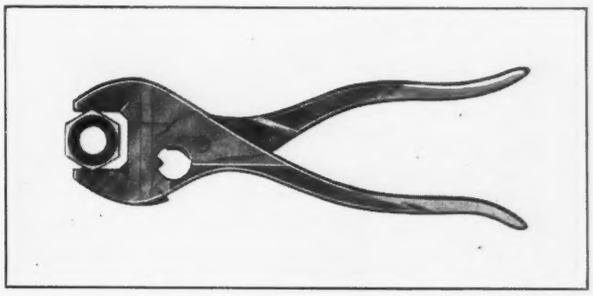
2-, 2½-, and 3-foot high-speed machines, and 3-, and 3½-foot heavy-duty machines. There are eighteen spindle speeds and six feeds available. The maximum spindle speed obtainable on the high-speed machines is 900 revolutions per minute, and on the heavy-duty machines, 650 revolutions per minute. Both types are equipped with an all ball-bearing speed-box, a ball-bearing-mounted spindle gear, and helical spindle gears. The spindle gears and those in the speed-box and back-gear unit are made of alloy steel and hardened. Multiple-disk friction clutches contained in the tapping attachment are adjustable from the outside, and this attachment runs in oil. Operating parts in the head, back bracket, and column cap are lubricated from oil reservoirs. The spindle sleeve is made of steel with the rack teeth cut directly in it.

SMITH BENCH LATHE TOOL-HOLDER

For holding a boring tool for use in bench lathe operations, the J. F. Smith Tool Co., 33 Westview Ave., Dayton, Ohio, has brought out the holder here illustrated. On one end of the shank of this holder there is a turned offset which is straigt-knurled. A clamp is fitted over this offset to hold the boring tool. This clamp is made in two parts so as to be adjustable to different heights. The screws in the center are tightened to draw the clamp into the straight knurling of the shank so as to bind it in place. Slipping is prevented by the knurling. There is a generous fillet where the offset joins the shank so as to obtain a strong design, and the clamp is countersunk to clear this fillet. One-quarter inch boring-bars of any length can be accommodated.



Smith Boring Tool Holder for Bench Lathes



Grip-N-Stik Combination Adjustable Wrench and Plier

GRIP-N-STICK COMBINATION WRENCH AND PLIER

The combination wrench and plier here illustrated has been placed on the market by the Grip-N-Stick Co., Dover, Ohio. One of the features of this appliance is that the jaws are always parallel, and they can be adjusted into four positions to suit the size of nut or other part that is to be gripped. To change the width of the jaw opening, the levers are opened to the limit, which leaves the movable jaw free to be opened further or closed by means of the thumb. The jaw is then re-engaged by merely closing the levers. The device is of simple construction, consisting of but four parts. It has a capacity for work ranging from a cotter-pin to the head or nut of a ¾-inch bolt. This tool is 7 inches long and weighs about 10 ounces.

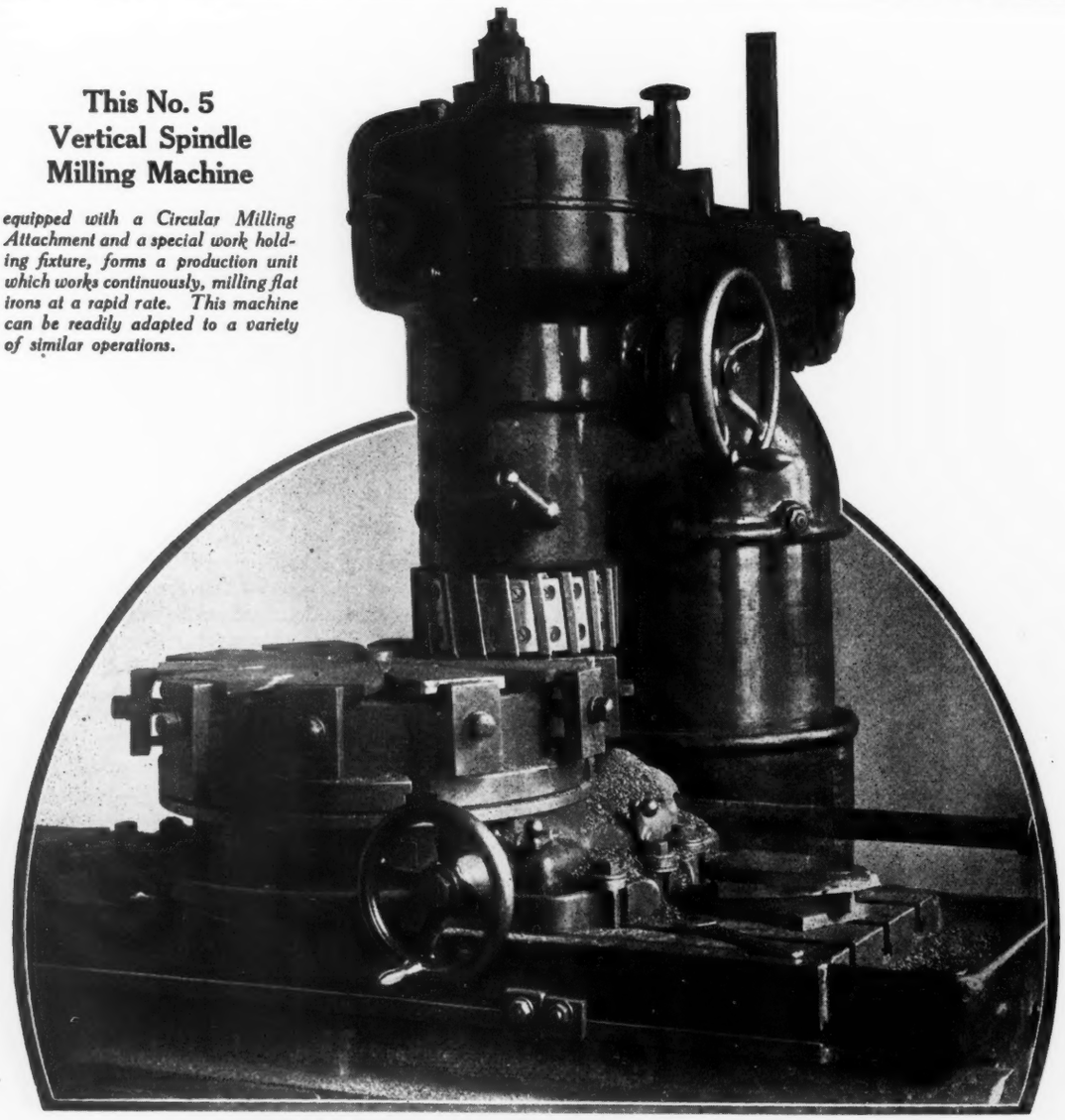
Haskins Motor-driven Portable Equipment

HASKINS PORTABLE EQUIPMENT

A motor-driven portable equipment intended for use in grinding, polishing, wire-brushing, and similar operations, which has recently been brought out by the R. G. Haskins Co., 518½ W. Monroe St., Chicago, Ill., is shown in the accompanying illustration. The motor is of ½ horsepower capacity, revolves at 1750 revolutions per minute, and swivels on a pedestal mounted on ball-bearing casters. The shaft is ½ inch in diameter, wire-wound, and revolves in an oil-tight casing.

This No. 5 Vertical Spindle Milling Machine

equipped with a Circular Milling Attachment and a special work holding fixture, forms a production unit which works continuously, milling flat irons at a rapid rate. This machine can be readily adapted to a variety of similar operations.



Years of Experience—that's why Brown & Sharpe can give sound advice on milling problems

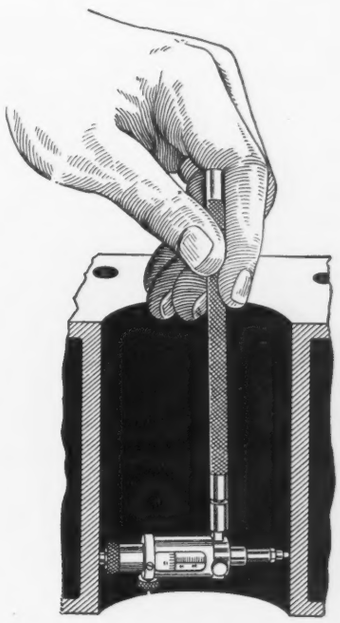
OVER 60 years of successfully manufacturing high-grade milling machines has brought the Brown & Sharpe Mfg. Co. in contact with a great variety of milling machine methods and operations.

Milling machine experts in our Engineering Department will gladly show you how this vast experience can be of assistance in solving your milling problems. Take advantage of this valuable service—talk over your milling problems with a Brown & Sharpe representative.

Catalog No. 137 lists our entire line of milling machines, including Plain, Universal, Vertical Spindle, Manufacturing and Automatic types. A copy of this catalog should be in the files of every user of milling machines. Have you one?

BROWN &

Inside Information—
the kind you can rely upon



WHEN it comes to getting inside measurements which can be relied upon, there is no better way of obtaining them than with the help of Brown & Sharpe Machinists' Tools.

There are Brown & Sharpe tools for taking all kinds of inside measurements and they give highly accurate readings. Even for the hard-to-get-at places there are handy tools which can be accurately and conveniently used. That is why so many good mechanics have them in their kits—they speed up their work even on the hardest jobs.

Ask your dealer about these inside measuring tools—have him show them to you.

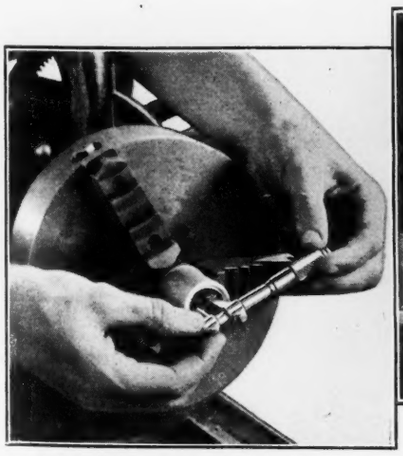
Brown & Sharpe Inside Measuring Tools

Inside calipers, inside micrometer caliper, vernier calipers, inside micrometers, depth gauges, thickness gauges, cylindrical gauges, taper cylindrical gauges, caliper gauges, limit gauges, taper parallel gauges, caliper rules, end measuring rods, caliper squares, die makers' squares.

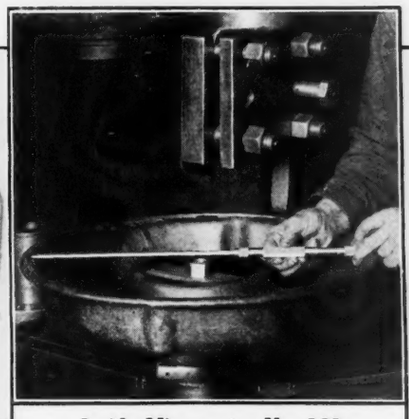
BROWN & SHARPE MFG. CO.
PROVIDENCE, R. I., U. S. A.

Manufacturers of
Machinists' Tools

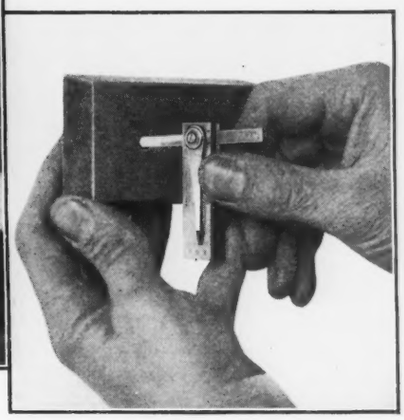
Milling Machines
Gear Cutting Machines
Screw Machines
Grinding Machines
Cutters and Hobs



Inside Micrometer Caliper No. 252



Inside Micrometer No. 262



Die Makers' Square No. 552

SHARPE

In addition to tools for inside measuring, the Brown & Sharpe Small Tool Catalog No. 29 lists others for a wide variety of uses—over 2000 of them in all. Ask your dealer for a copy of this catalog or write to us direct.

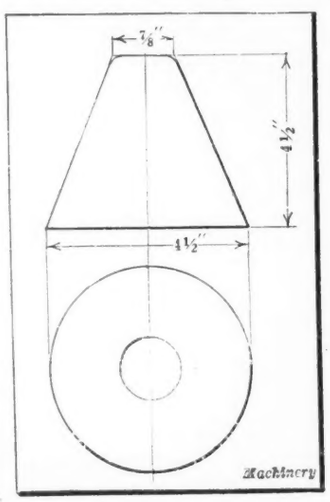
Questions and Answers

RESHARPENING FILES

K. B.—Can any reader of MACHINERY tell me how to resharpen files with acid solution?

A DRAWING JOB

W. S. F.—A cone-shaped piece like that shown in the accompanying illustration is to be made from stock 0.020 or 0.025 inch thick. Would it be possible to draw this piece in one operation, and if so, how would the drawing die be made? Which material would be preferable to use for the cone-shaped piece to be made—aluminum, dead soft brass, or deep drawing steel?



Cone-shaped Piece to be drawn in One Operation

SHRINKAGE STRAINS IN CAST-IRON WHEEL

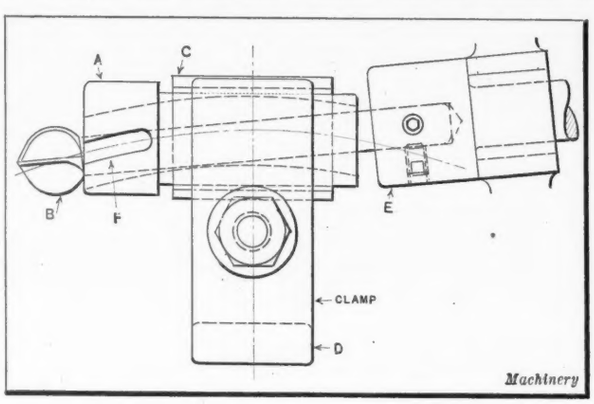
E. A. R.—We have experienced some difficulty in obtaining castings for a large six-spoked wheel that did not have shrinkage cracks in the spokes. Can the pattern be modified in any way to eliminate this trouble?

A.—It is assumed that since the shrinkage cracks occur in the spokes, the latter are relatively light in construction, as compared with the rim and hub of the wheel. If this is the case, the trouble might be eliminated by splitting the hub of the pattern so that each half of the hub would be supported by three spokes and entirely separated from the other half. When the hub is made in two parts, there are practically no shrinkage strains in either part, although the cost of machining the split hub and fitting the parts so that the hub can be clamped together with bolts might be prohibitive.

MACHINING A HOLE ALONG AN ARC

ANSWERED BY EDMUND C. PERSANS, BROOKLYN, N. Y.

In December MACHINERY on the Question and Answers page, W. E. H. asks how to machine a piece having a hole which coincides with a circular arc in a lengthwise direction. A method of performing such an operation is illustrated by the accompanying diagram. The piece *A* through which a hole is to be machined (as indicated by the dotted line) is clamped into a V-block *C* with clamp *D*. These work-holding members are mounted on a fixture arranged to swing on an 8-inch radius and equipped with a suitable feeding attachment. The hole is machined along an arc as the work *A* is fed against a cutter or end-mill *B*, the shank of which is small enough to clear the hole, as the illustration shows. This cutter should have about five flutes, and it is mounted either in a special spindle head *E* or in a milling machine chuck. The slot *F*, the curvature of which conforms to the center line of the hole, can be end-milled by using the same fixture on a vertical milling machine.



Method of machining a Hole whose Center Line coincides with an Arc

PHOTOGRAPHING BLUEPRINTS

M. B. W.—The writer recently attempted to make photographic copies of several blueprints with indifferent success. Will you kindly explain how photographs can be made that will show clearly the details on the blueprints?

A.—It is not an easy task to photograph blueprints. Ordinary orthochromatic plates with yellow filters do not give the best results owing to the fact that a great deal of the yellow-green light to which such plates are sensitive is reflected by the blueprint. This trouble has been eliminated, and satisfactory results have been obtained by using a deep-red filter with panchromatic plates, thus photographing the print by red light which completely absorbs the blue. With such a filter and plate, the negatives made from blueprints have been found to be as satisfactory as could be obtained from photographing a black-and-white print in the ordinary way.

DEFENSE IN A PATENT INFRINGEMENT SUIT

F. H. S. S., Inc.—We have been threatened with a suit for an infringement of a patent, and believe that we are in a position to prove that the patentee is not the inventor of the subject matter on which the patent is based, and that the invention was in use for a considerable length of time before the date on which the application for the patent was filed. May we ask you to inform us what defenses are possible in infringement actions?

ANSWERED BY GLENN B. HARRIS, YONKERS, N. Y.

Initially my advice is that you engage a thoroughly competent patent lawyer to conduct your case. Patent law is a highly specialized branch of practice and requires a thorough knowledge of it for a competent handling of an infringement case.

There are a number of defenses in an infringement action. It may be set up that for the purpose of deceiving the public, the specification filed by the patentee was made to contain less than the whole discovery, or more than was necessary to produce the desired result; that the patent was surreptitiously obtained, in that it was the invention of another who was using due diligence in perfecting the same; that it had been patented or described in a printed publication more than two years prior to his application for the patent; that the patentee was not the original and first inventor of any material or substantial part of the thing patented; or that the invention had been in public use or on sale in this country for more than two years prior to his application, or that the patent had been abandoned to the public. Any of these defenses, when substantiated, will invalidate a patent.

* * *

In December the U. S. Steel Corporation operated at 75 per cent of its ingot capacity, compared with 60 per cent four weeks previously.

MEET BETTER BUSINESS WITH BETTER MACHINES

PATENT NOTICE

In addition to our own patents, we are licensed under all the basic centerless grinding patents, including the Heim reissue patent 15035, recently sustained by the decision of the U. S. Circuit Court of Appeals. In the purchase of our machines, therefore, our customers are protected against infringement of centerless grinding patents.

The Cincinnati Centerless Grinder handles a large variety of work. New jobs are being found daily which increase the profitableness and usefulness of this machine.

Steel, iron, glass, fibre, wood, raw-hide, rubber, and reed are among the materials now ground.

Cylindrical, shoulder and form work can be handled profitably by The Cincinnati Centerless Grinder. Hundreds of users bear testimony to the fact that the installation of this machine has been the most profitable investment that they have made in years. The machine frequently pays for itself within a year or less.

Perhaps your work can be handled by the Centerless method. Send us your blueprints and sample parts for a complete estimate. Ask for Our Booklet "Examples of Centerless Grinding."

THE CINCINNATI MILLING MACHINE CO.,
CINCINNATI, OHIO

The machine below paid for itself in less than 6 months

The in-feed method of centerless grinding is used on this job to form fountain pen barrels to the required shape ready for finish polishing at the rate of 1000 per hour. THIS IS AN INCREASE IN PRODUCTION OF 110%.

CINCINNATI CENTERLESS GRINDERS

TRADE NOTES

TRIUMPH ELECTRIC CO., Cincinnati, Ohio, has appointed the John F. Folkers Engineering Corporation, Mobile, Ala., agent to handle its sales and service in the Mobile territory.

CLEVELAND WORM & GEAR CO., Cleveland, Ohio, has moved from E. 40th St., to larger quarters at 3249-3299 E. 80th St., south of Kinsman Road, Cleveland. The new plant has double the capacity of the former one.

DIEFENDORF GEAR CORPORATION, Syracuse, N. Y., has acquired the patterns, good will, and some of the machinery of the MEACHEM GEAR CORPORATION, and will move the equipment to its new plant at 920 W. Belden Ave.

NORMA-HOFFMAN BEARINGS CORPORATION has moved its factory and general offices from Long Island City to its new plant at Stamford, Conn. The Long Island City office has been discontinued, and all shipments will now be made from the Stamford plant.

MILES MACHINERY CO., 207 Bearinger Bldg., Saginaw, Mich., dealer in new and used machinery, has purchased, for resale purposes, the entire equipment of the Simplex Wire Wheel Co. of Cadillac, Mich., including from thirty to forty machine tools and miscellaneous shop equipment.

MILBURN SALES CO., distributor in the Philadelphia territory for the Alexander Milburn Co., 1416 W. Baltimore St., Baltimore, Md., manufacturer of oxy-acetylene welding and cutting apparatus and portable carbide lights, has taken over the Metropolitan New York district, with headquarters at 309 Fifth Ave.

MARR-GALBREATH MACHINERY CO., Pittsburg, Pa., dealer in new and used metal and woodworking machinery and equipment, has changed its location from 127 Water St. to 58 Water St. The new warehouse, which runs through from Water St. to 56 First Ave., will afford the company double its present floor space.

PAWLING & HARNISCHFEGER CO., 38th and National Aves., Milwaukee, Wis., announces that the name of the company has been changed to the HARNISCHFEGER CORPORATION, effective January 1. This change in name does not involve any change in the management, personnel or policy of the company. The P & H trademark will be retained.

SOUTHWARK FOUNDRY & MACHINE CO., Philadelphia, Pa., manufacturer of hydraulic equipment, power tools, and special machines, announces that its Cleveland office has been discontinued and that its business in that territory will be conducted in the future from 100 E. South St., Akron, Ohio. F. H. Smith will be in charge of the Akron office.

VONNEGUT MACHINERY CO., Indianapolis, Ind., held an extensive exhibition of machine tools, power transmission equipment, and small tools during the week beginning December 15. Many of the motor-driven machine tools were demonstrated in operation. The exhibition was visited by engineers and manufacturers from all parts of Indiana and adjacent states.

GIBB INSTRUMENT CO., Bay City, Mich., has changed its name to GIBB WELDING MACHINES CO. This is a change in name only and denotes no change in organization. As the company no longer makes instruments, but is engaged exclusively in the manufacture of electric welding and heating machines, the new name was adopted as being more exactly descriptive of the product.

AUSTIN CO., Cleveland, Ohio, engineer and builder, has removed its San Francisco office to larger quarters at 244 Kearny St. The company also announces that its headquarters' staff at Los Angeles recently moved into its new home at 777 E. Washington St. One of the contracts recently obtained is for the construction of a storage warehouse at Fort Wayne, Ind., for the International Harvester Co.

COMBUSTION UTILITIES CORPORATION, 8 Bridge St., New York City, announces the consolidation of its appliance and industrial furnace departments with those of the Surface Combustion Co., Inc., and will operate under the name of the latter company, as the Utilization Division of the Combustion Utilities Corporation. The Surface Combustion Co. will continue its sales and general offices at 363 Gerard Ave., Bronx, N. Y.

STOCKBRIDGE MACHINE CO., Worcester, Mass., manufacturer of the Stockbridge two-piece crank shaper, has appointed the following direct sales representatives: D. J. Normoyle, 514 Liberty Building, Philadelphia, Pa.; Starr Equipment Co., Arrott Building, Pittsburg, Pa.; D. E. Morand Machinery Co., 8784 Quincy Ave., Detroit, Mich.; the N. C. Failor Co., 30 Church St., New York City; and G. A. Pabst, 106 S. Jefferson St., Chicago, Ill.

WILLIAM F. ZIMMERMANN, chief engineer of the Gould & Eberhardt Co., Newark, N. J., has been awarded the Edward Longstreth Medal by the Franklin Institute of Philadelphia, Pa., in recognition of his invention relating to a hob for worm-gears and the method of making it. The Longstreth Medal is awarded for outstanding achievements in engineering and "for the encouragement of invention and in recognition of meritorious work in science and industrial arts."

AUSTIN CO., engineer and builder, 16112 Euclid Ave., Cleveland, Ohio, in anticipation of greatly increased activity in the industrial construction field, will begin to place orders for materials to cover 1925 requirements within the next few weeks. In the metal field these requirements will include 10,000 tons of steel shapes, plates, and bars; 30,000 tons of fabricated structural steel for buildings; 12,000 square feet of steel rolling doors; 1,400,000 square feet of steel sash; and 43,000 lineal feet of mechanical sash operating devices.

BLACKMER ROTARY PUMP CO., Petoskey, Mich., has placed a contract for the construction of a new plant in Grand Rapids, Mich., with the Owen, Ames, Kimball Co. The plant will be located on Century Ave. between Griggs and Plett Sts. The building now under construction is 90 by 345 feet, and will house the machine shop and office. To this will be added a power house and foundry, giving a total floor space of approximately 47,000 square feet. The cost of the buildings will be about $100,000. It is expected that the machine shop will be in operation by February 1.

OAKLEY CHEMICAL CO., 26 Thames St., New York City, held its annual conference on industrial cleaning, December 1 to 4, at the Hotel Pennsylvania, and at the company's offices at 22 Thames St., New York City, at which eighty men of the technical, laboratory, and sales and service staff were present, including the seventy field-service men employed by the company. A carefully laid out program of sixteen technical papers covered cleaning methods in the major industries, including metal cleaning in machine shops, automobile factories, power plants, and railroad shops.

ELECTRIC ARC CUTTING & WELDING CO., 152 Jelliff Ave., Newark, N. J., manufacturer of portable cutting and welding devices, electrodes, and welding supplies, announces that the Circuit Court of Appeals of the District of Columbia has just rendered a decision sustaining the concurrent decisions of all the tribunals of the United States Patent Office in awarding C. J. Holslag priority of invention over Charles B. Waters on the subject of alternating-current arc welding transformers. The Electric Arc Cutting & Welding Co. has already licensed one company to operate under its patent rights, and it is intended to grant a few more licenses.

LINK-BELT CO., 910 S. Michigan Ave., Chicago, Ill., has erected a new warehouse and office building at 5938 Linsdale Ave., Detroit, Mich. The new structure is two stories, and houses not only the general office for the Detroit branch, but also a large warehouse where standard Link-Belt and H. W. Caldwell & Son Co. products are kept in readiness for immediate shipment. The stock includes chains for elevating, conveying, and power transmission purposes; sprockets; clutches; malleable-iron elevator buckets, etc. The company has moved its St. Louis branch office from 705 Olive St. to larger and more conveniently located quarters at 3638 Olive St.

FOOTE BROS. GEAR & MACHINE CO., 232-242 N. Curtis St., Chicago, Ill., manufacturer of IXL gear products and speed reducers, announces the establishment of the following sales offices and agencies: 321 N. 21st St., Birmingham, Ala.; 740 Commonwealth Ave., Boston, Mass.; Jackson Bldg., Buffalo, N. Y.; 3221 Scranton Road, Cleveland, Ohio; 1275 Broadway, Denver, Col.; 316 Caswell Block, Milwaukee, Wis.; 100 Greenwich St., New York City; Charles Bond & Co., 617 Arch St., Philadelphia, Pa.; 1306 Keenan Bldg., Pittsburg, Pa.; 817 Lewis Bldg., Portland, Ore.; Ingersoll, Erskine & Healy, Rochester, N. Y.; 405-407 Franklin Ave., St. Louis, Mo.; National Equipment Co., Salt Lake City, Utah; 1143 Henry Bldg., Seattle, Wash.; 632 Nasby Bldg., Toledo, Ohio; Central District Co. and Palmer Electric Co., Detroit, Mich.; Darling Bros., 120 Prince St., Montreal, Canada; and Thrall Electric Co., Havana, Cuba.

* * *

PROPOSED MUSEUM OF ENGINEERING

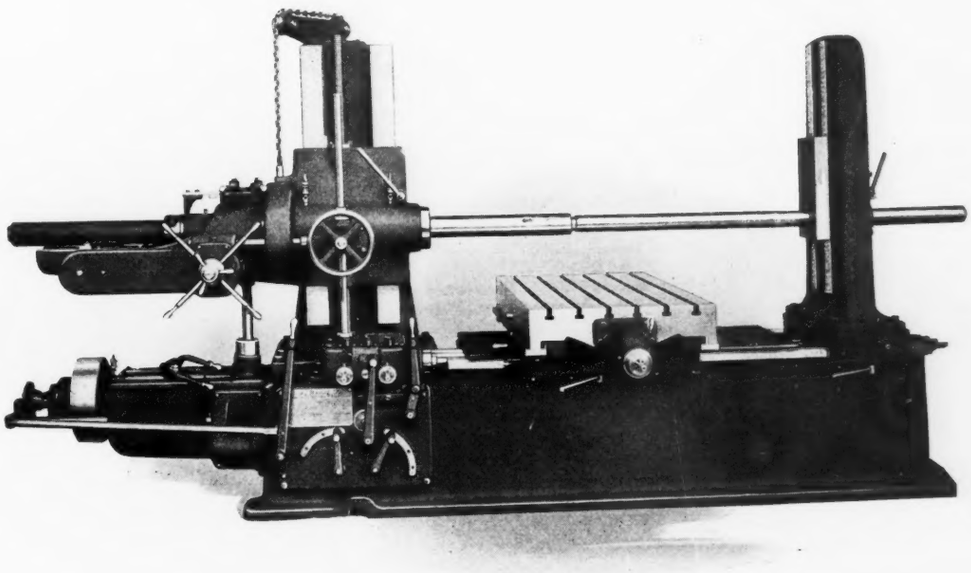
A booklet has been published by the organization furthering the establishment of a National Museum of Engineering and Industry, of which Dr. Elihu Thomson is president. This booklet contains an illustration of the proposed building for the National Engineering Museum, and also illustrations of the national museums of engineering in Great Britain, France, Germany, and Austria, indicating a need for such a museum in this country that would compare favorably with what has been done abroad. Copies of the booklet may be obtained from the secretary of the National Museum of Engineering and Industry, H. F. J. Porter, 29 W. 39th St., New York City.

"Good Business Ahead—Let's Go!"

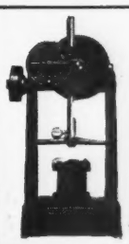
Don't hesitate until you are swamped with work and need the machine "yesterday" before ordering your LUCAS

"PRECISION"

Horizontal Boring, Drilling and MILLING MACHINE



Have it installed ready to go ahead making money for you at the BEGINNING of the rapidly approaching business improvement and thereby take FULL ADVANTAGE of the profitable business to be had in your line.



WE ALSO MAKE THE

LUCAS POWER Forcing Press

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich, V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Paris and Rotterdam. Andrews & George Co., Tokyo.

PERSONALS

A. H. KRIGGER, 404 House Bldg., Pittsburg, Pa., has taken over the sales for the Pittsburg territory of the electric industrial trucks and tractors made by the Crescent Truck Co., of Lebanon, Pa.

J. F. KROSKE has been appointed manager of pneumatic tool sales in the Pittsburg territory for the Ingersoll-Rand Co., 11 Broadway, New York City. Mr. Kroske's headquarters will be in Pittsburg.

P. BLAIR LEE, who has been engaged in special work for the vice-president and general manager of the Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa., has been appointed works manager of the company.

J. R. LAWRENCE, for seven years with the Motch & Merryweather Machinery Co., of Cleveland, Ohio, is now connected with the sales department of the Marshall & Huschart Machinery Co., 17 S. Jefferson St., Chicago, Ill.

R. C. BROACH has been appointed southeastern district manager for the Heine Boiler Co., with offices at 709 Glenn Bldg., Atlanta, Ga. His territory includes eastern Tennessee, North and South Carolina, Alabama, Georgia, and Florida.

GUY HUBBARD, who for nine years has been connected with the engineering department at the Windsor, Vt., plant of the National Acme Co., is now assistant to Henri A. Sévigné, manager of the National Bread Wrapping Machine Co., of Nashua, N. H.

A. L. ABRAHAMS has recently joined the Kny-Scheerer Corporation of America, 119 Seventh Ave., New York City, in the capacity of general factory manager. Mr. Abrahams was formerly connected with the Hale & Kilburn Corporation of Philadelphia.

THOMAS C. MCBRIDE, Philadelphia manager of the Worthington Pump & Machinery Corporation, 115 Broadway, New York City, has been awarded the Edward Longstreth medal of the Franklin Institute, in recognition of his invention of the Worthington locomotive feed-water heater.

H. V. BERONIUS has been appointed representative in Iowa, Kansas, Nebraska, Oklahoma, and northwestern Missouri for the Gibb Instrument Co., of Bay City, Mich., manufacturer of electric welding and heating equipment. His headquarters will be at 33 Linwood Terrace, Kansas City, Mo.

A. B. COOPER has been appointed Philadelphia district sales manager of the Central Steel Co., Massillon, Ohio, manufacturer of Agathon alloy steels. Mr. Cooper's offices will be in the Widener Bldg. in Philadelphia. He was formerly connected with the Tacony Steel Co. and the Penn Seaboard Steel Corporation.

STODDARD B. MARTIN, who was for ten years with the Windsor Machine Co. and its successor the National Acme Co. (a large part of this time with the Gridley interests in France), is now representing the Cone Automatic Machine Co., of Windsor, Vt. Mr. Martin's headquarters are at 1899 E. 82nd St., Cleveland, Ohio.

K. L. CLARK has been appointed western representative of the tool steel department of Henry Disston & Sons, Inc., Philadelphia, Pa. His headquarters will be at Washington Boulevard and Jefferson St., Chicago, Ill. Prior to affiliating with the Disston organization, Mr. Clark was associated with the Firth Sterling Steel Co. and the Latrobe Electric Steel Co. in the sale of tool steel in Detroit and Chicago.

C. C. HERMANN, formerly connected with the engineering department of Deere & Co., of Moline, Ill., and recently with the Litchfield Mfg. Co., of Waterloo, Iowa, as chief engineer and general superintendent, has opened an office at 219 Virden St., Waterloo, Iowa, as consulting mechanical and industrial engineer. Mr. Hermann is the author of the series of articles on "Machine Forging" that has been published during the past year in MACHINERY.

FRANCIS C. PRATT, vice-president in charge of engineering of the General Electric Co., Schenectady, N. Y., will fill the vacancy caused by the resignation of G. E. Emmons, as vice-president in charge of manufacturing and chairman of the manufacturing committee. Mr. Pratt's new title will be vice-president in charge of engineering and manufacturing. H. F. T. ERBEN has been appointed assistant vice-president on the staff of Mr. Pratt. He will continue as vice-chairman of the manufacturing committee. Mr. Pratt's engineering assistant is E. W. ALLEN, appointed to the position of manager of the engineering department in April, 1924.

OBITUARIES

JOHN LYELL HARPER, vice-president and chief engineer of the Niagara Falls Power Co., died November 28 at the Memorial Hospital in Niagara Falls, N. Y., following an operation for appendicitis. He was fifty-one years old, having been born in Harpersfield, N. Y., September 21, 1873. Mr. Harper was one of the most prominent hydro-electric engineers in America, and was responsible to a large extent for the development of the Niagara Falls Power Co. He was associated with that concern and its predecessor for twenty-two years, starting in the company's employ as an assistant engineer.

EMORY E. ELLIS, president and general manager of the Union Tool Co., Orange, Mass., died November 15 at the Gardner (Mass.) Hospital, following an operati n for appendicitis. Mr. Ellis was fifty-four years old at the time of his death. He was first employed by the Brown & Sharpe Mfg. Co., Providence, R. I. Later he became associated with the Athol Machine Co., Athol, Mass., going from that concern to the Sawyer Tool Co., Fitchburg, Mass., as superintendent. Still later, Mr. Ellis formed the Union Caliper Co. at Fitchburg, but subsequently removed the business to Orange. In 1908 the company was incorporated under the name of the Union Tool Co. J. C. Bates, formerly associated with Mr. Ellis at the Sawyer Tool Co., succeeds Mr. Ellis as general manager.

COMING EVENTS

JANUARY 19-22—Annual meeting of the Society of Automotive Engineers at Detroit, Mich. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

JANUARY 28-30—Annual convention of the American Management Association in New York at the Hotel Astor. Secretary's address, 20 Vesey St., New York City.

MAY 6-8—National convention of the Society of Industrial Engineers in Cleveland, Ohio; headquarters, Hotel Winton. Executive secretary, George C. Dent, 608 S. Dearborn St., Chicago, Ill.

MAY 11-23—(instead of January 19-31) Southern Exposition to be held at Grand Central Palace, New York City. Further information may be obtained from William G. Sirrine, Greenville, S. C., or the Merchants' Association of New York, 233 Broadway, New York.

JUNE 16-19—Summer meeting of the Society of Automotive Engineers at Greenbrier Hotel, White Sulphur Springs, W. Va. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

JUNE 22-26—Annual meeting of the American Society for Testing Materials at Chalfonte-Haddon Hall, Atlantic City, N. J. Secretary-Treasurer, C. L. Warwick, Engineers' Club Building, 1315 Spruce St., Philadelphia, Pa.

JUNE 24-26—Twelfth National Foreign Trade Convention in Seattle, Wash. Secretary of the National Foreign Trade Council, O. K. Davis, India House, Hanover Square, New York City.

NEW BOOKS AND PAMPHLETS

VACUUM TUBE OSCILLATORS. By J. W. Horton. 17 pages, 6 by 9 inches. Published by the Western Electric Co., Inc., 195 Broadway, New York City.

HINTS ON AUTOMOBILE MAINTENANCE. By H. A. Huebotter. 11 pages, 6 by 9 inches. Published by Purdue University, Lafayette, Ind., as Circular No. 3 of the Engineering Extension Service.

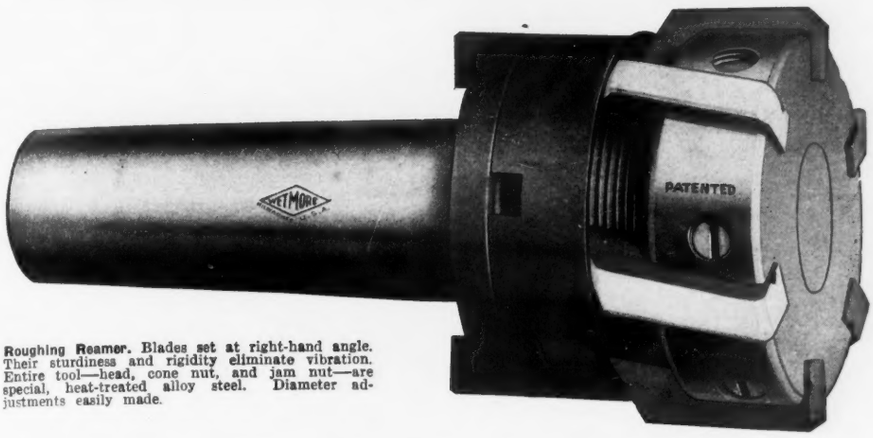
MODERN THEORY AND PRACTICE OF PUMPING. By Norman Swinden. 364 pages, 7 by 10 inches; 281 illustrations. Published by the D. Van Nostrand Co., 8 Warren St., New York City. Price, $10.

This is a treatise on the application of the Reynolds-Stanton law of viscous flow to modern pumping problems and the flow of liquids through pipes, of interest principally to the chemical engineer. The work is a more detailed treatment of the subjects dealt with in two previous books of the author's—"The Flow of Liquids in Pipes," and "Pumping in the Mechanical Works." It contains a description of many types of pumps in use for pumping corrosive, gritty, solid-laden, and viscous liquids outside the scope of the hydraulic engineer, and does not deal with the pumping of water.

INDUSTRIAL COAL—PURCHASE, DELIVERY, AND STORAGE. 419 pages, 5¾ by 8½ inches. Published by the Ronald Press Co., 20 Vesey St., New York City. Price, $5.

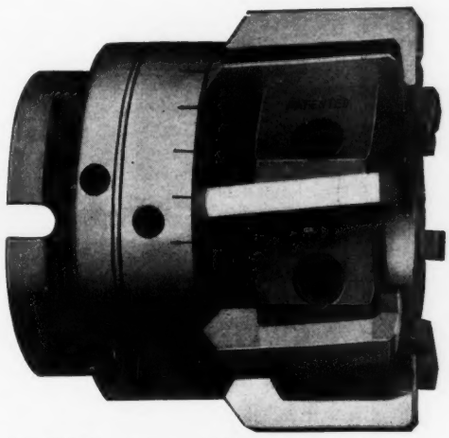
An extensive investigation has been conducted by the American Engineering Council for the purpose of discovering the factors underlying the stabilization of coal for industrial use. The results are published in this book. Those who are responsible for maintaining an uninterrupted fuel supply will be interested in the conclusions presented, which show the possibility of improving the method of purchase, delivery, and storage of coal. The greatest obstacle to continuous operation in the coal industry is the lack of adequate storage facilities, and the report recommends a more general practice on the part of the consumer, of storing coal, pointing out that the most logical and advantageous point of storage is in the bin of the consumer.

THE BIG THREE



Roughing Reamer. Blades set at right-hand angle. Their sturdiness and rigidity eliminate vibration. Entire tool—head, cone nut, and jam nut—are special, heat-treated alloy steel. Diameter adjustments easily made.

—why Wetmore Cylinder Reaming Sets Speed Up Production

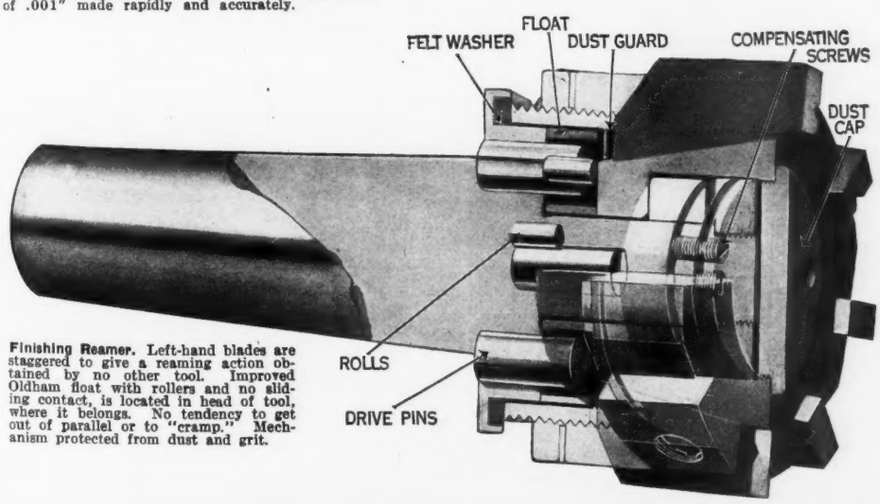


Semi-Finishing Reamer. Left-hand angle blades eliminate digging in and chattering. Adjustments of .001" made rapidly and accurately.

Unusual *durability* and *sturdiness*, plus *greater working speed* and *less vibration*—that's the combination you get in the three expanding reamers of Wetmore Cylinder Reaming Sets!

Note the extreme ruggedness of the Roughing Reamer (top). The Semi-Finishing Reamer (middle), with its left-hand angle blades, eliminates digging in and chattering. It assures a straight, round hole with no scoring. The construction of the Finishing Reamer (bottom) assures a smooth, glass-like finish to the cylinder wall.

Wetmore Cylinder Reamers are standard in many of the largest motor manufacturing plants. A trial in your shop, in competition with other reamers, will prove that they save time and money.



Finishing Reamer. Left-hand blades are staggered to give a reaming action obtained by no other tool. Improved Oldham float with rollers and no sliding contact, is located in head of tool, where it belongs. No tendency to get out of parallel or to "cramp." Mechanism protected from dust and grit.

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WETMORE EXPANDING REAMERS

"THE BETTER REAMER"

STANDARD ELECTRICAL DICTIONARY. By T. O'Conor Sloane, with additions by Professor A. E. Watson. 790 pages, 5 by 7 inches. Published by the Norman W. Henley Publishing Co., 2 West 45th St., New York City. Price, $5.

The new edition of this electrical dictionary has been greatly enlarged and brought up to date. Among the additions to the present volume is a dictionary of radio terms. The entire work contains definitions of about six thousand words, terms, and phrases. The material is divided into three parts, the first part representing the original volume and the second and third parts later additions, part three containing the definitions of radio terms. The book comprises more than a mere dictionary, as it contains, besides definitions, considerable additional information, as well as illustrations. It is unfortunate that the addition of two supplementary parts makes it necessary for the person using the dictionary to refer to three different sections.

A LABORATORY MANUAL OF MACHINE SHOP PRACTICE. By Jerry H. Service and George E. Frease. 106 pages, 5 by 7¾ inches. Published by the D. Van Nostrand Co., 8 Warren St., New York City. Price, $1.25.

While the teaching of vocational subjects is best conducted by those who have earned a living in their respective vocations and who are familiar with commercial requirements and methods, such teachers often experience difficulty in organizing and conducting a course that will develop in the students the ability to earn a living. This book has been written primarily to help practical machinists to teach machine shop practice. It is intended to be more than a mere text-book, the purpose being to lay out a distinct course that can be followed in the shop and that will serve as a guide for the preparation of lectures. The book is entirely made up of exercises in shop work. The jobs are designed to cover the essential bench, drill press, engine lathe, milling machine, planer, and shaper operations. A list of topics suitable for supplementary lectures and group discussions is given in the appendix, and also a list of equipment and material required for the course.

MECHANICS OF TEXTILE MACHINERY. By William A. Hanton. 236 pages, 5½ by 8½ inches. Published by Longmans, Green & Co., 55 Fifth Ave., New York City. Price, $4.20, net.

The lack of a text-book dealing with the application of mechanics to textile engineering in technical colleges and schools has led the author of this book, who is a lecturer in textile engineering in the College of Technology, Manchester, England, and in the University of Manchester, to prepare the present work. The aim has been to provide a book that will be useful both to students and to the designer and user of textile machines. It is expected that the reader will have an elementary knowledge of mechanics and of the general working of textile machinery. Throughout the text, numerous examples are given, and the appendix contains a large number of questions and answers. The book is divided into five parts: The first part contains an introductory chapter on the principles of elementary mechanics and a more advanced study of the parts of mechanics needed in studying the working of machinery. The other four parts treat of spinning machinery; preparatory machinery; the power loom; and driving and testing textile machinery.

INDEX TO THE TRANSACTIONS OF THE A. S. M. E. 222 pages, 6 by 9 inches Published by the American Society of Mechanical Engineers, 29 W. 39th St., New York City. Price, $3.

This book contains an index of all the Transactions of the society, including Volumes 1 to 45. This is the first general index covering all the volumes that has been published. In preparing the present index, the intention has been to cover as thoroughly as possible material contained in the discussions, as well as in the papers, which on account of its subject matter might escape the attention of the searcher in an index devoted primarily to the major subjects of formal papers. The index should greatly increase the value of the transactions, bringing to light as it does much hitherto unindexed material. The items have been very fully cross-referenced for the assistance of users. The present index applies particularly to Volumes 26 to 45, inclusive, only a sufficient number of references to the first twenty-five volumes being included to locate the papers and their authors. The general style of the engineering index has been followed, all items being grouped alphabetically under authors' names and subjects, except memorial notices of deceased members, which are given in a separate list at the end of the book.

NEW CATALOGUES AND CIRCULARS

STEAM ENGINES. Mesta Machine Co., Pittsburg, Pa. Bulletin U-2, descriptive of the economies obtained with "Una-flow" engines.

ELECTRIC FITTINGS. Crouse-Hinds Co., Syracuse, N. Y. Circular illustrating safety switch condulets, made in water-tight and non-water-tight types.

MOTORS. Triumph Electric Co., Cincinnati, Ohio. Circular containing a reprint of an article on the TR self-start motor published in the *Iron Trade Review*.

ELECTRICAL EQUIPMENT. General Electric Co., Schenectady, N. Y. Calendar for 1925, each sheet of which illustrates, in color, different applications of electricity.

TWIST DRILLS. Whitman & Barnes Mfg. Co., Akron, Ohio. Calendar for 1925 containing three months on each sheet and illustrating W & B twist drills and reamers.

ELECTRIC STARTERS. Monitor Controller Co., Baltimore, Md. Bulletin 106, illustrating and describing Monitor "thermaload" starters for small alternating-current motors.

PYROMETERS. Taylor Instrument Companies, Rochester, N. Y. Bulletin illustrating and describing the "Tycos" thermopyre, a self-contained, high-temperature, portable pyrometer.

AIR COOLERS. General Electric Co., Schenectady, N. Y. Bulletin 45609, describing in detail the construction, principles of operation and exclusive features of the G-E surface air cooler.

ELECTRIC DRILLS. Hisey-Wolf Machine Co., Cincinnati, Ohio. Bulletin 3018-S, descriptive of the new Hisey electric slate and marble drill, which is also adapted for some glass drilling operations.

DROP-FORGINGS. Union Switch & Signal Co., Swissvale, Pa., is distributing a calendar for 1925, containing three months on each sheet and a brief statement relating to the drop-forgings produced by this concern.

COUNTERBORES. Gairing Tool Co., Inc., Detroit, Mich. Circular of Gairing counterbores, spot-facers and core drills, illustrating the different types and showing these tools in use in a four-spindle gang drill, on a specific job.

BRASS ROD. Bridgeport Brass Co., Bridgeport, Conn., is distributing a chart called a "Rod-o-graph," for determining the weight of 1000 pieces of rod in different diameters and lengths, and either round, square, hexagon, or octagon in shape.

RUST PREVENTIVE. American Rust Proof Co., 8 W. 40th St., New York City. Booklet entitled "Rust and Rust Prevention," discussing the corrosion of steel and iron products, and describing the value of "Vatu" as a rust-preventive medium.

STEAM TURBINES. General Electric Co., Schenectady, N. Y. Bulletin 42019A, descriptive of Curtis steam turbines for mechanical drive, which are especially adapted for driving circulating and boiler feed pumps or other centrifugal pumps, fans, blowers, etc.

FORGINGS. American Forge Co., 2625 S. Hoyne Ave., Chicago, Ill. Catalogue containing information on the "Am Forge" process of manufacturing upset forgings. Various examples of work are shown, and comparative data of upset and hammered forgings are included.

SCREW THREAD COMPARATOR. Jones & Lamson Machine Co., Springfield, Vt. Circular descriptive of the bench type of Hartness screw thread comparator which embodies all the essential elements of the standard Hartness comparator, but is smaller and more compact.

POWER TRANSMISSION MACHINERY. W. A. Jones Foundry & Machine Co., 4409 W. Roosevelt Road, Chicago, Ill. Catalogue 31, covering Jones power transmission machinery, including shaft hangers, pillow blocks, couplings, collars, belt tighteners, mule stands, bench legs, etc.

TURRET LATHES. Warner & Swasey Co., Cleveland, Ohio. Catalogue treating of the new No. 4 universal turret lathe provided with a twelve-speed head, which has recently been brought out by this company. Two typical set-ups are illustrated, and data relative to these jobs are given.

DRILLING MACHINES. Charles Stecher Co., 2452 N. Greenview Ave., Chicago, Ill. Circular illustrating and describing the Stecher automatic universal drilling machine, which is designed both for the large-scale production of holes in small parts and for all-around use as a power-fed or sensitive hand-fed drill press.

MILLING CUTTERS. Goddard & Goddard Co., Detroit, Mich., is now distributing Nos. 3 and 4 of a series of pamphlets entitled "Real Production Tools." Pamphlet 3 illustrates the use of alternate-tooth cutters for milling keyways or deep slots. Pamphlet No. 4 describes the features of "Go & Go" metal slitting saws.

SHAPERS. Gould & Eberhardt, Newark, N. J. Bulletin 124, illustrating and describing the G & E standard high-duty and invincible shapers, in which several improvements have been incorporated. Bulletin 133, describing the outstanding features of the Gould & Eberhardt line of high-duty shapers which are made in 16-, 20-, 24-, and 32-inch sizes.

CONTOUR MEASURING PROJECTOR. Bausch & Lomb Optical Co., Rochester, N. Y. Catalogue descriptive of the Bausch & Lomb contour measuring projector, which is a precision optical instrument adapted for measuring screw threads, plug and ring gages, taps, dies, gears, forming tools, hobs, profile gages, and small form work of many kinds.

RADIAL DRILLS. Western Machine Tool Works, Holland, Mich. Catalogue 25, illustrating and describing the complete line of plain and universal radial drilling machines made by this company. Both types of machines are made with a low-hung drive. The construction is described in detail and illustrated both with halftone and line drawings.

BALL BEARINGS. New Departure Mfg. Co., Bristol, Conn. Sheet No. 158 FE for loose-leaf binder, illustrating the application of New Departure double-row ball bearings in low-duty centrifugal pumps. Sheet No. 163 FE for loose-leaf binder, illustrating the installation of New Departure ball bearings in electric arc welding machines and centrifugal pulverizing and blending mills.

ELECTRICAL EQUIPMENT. Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has published a report of the engineering achievements of the company for the year 1924, covering the new equipment and machinery brought out, as well as other developments. Readers of MACHINERY will be especially interested in that section that relates to the machine shop. Attention is called to the fact that a complete line of variable-voltage reversing planer equipments has been developed during the year, and some of the equipments have already been placed in service.